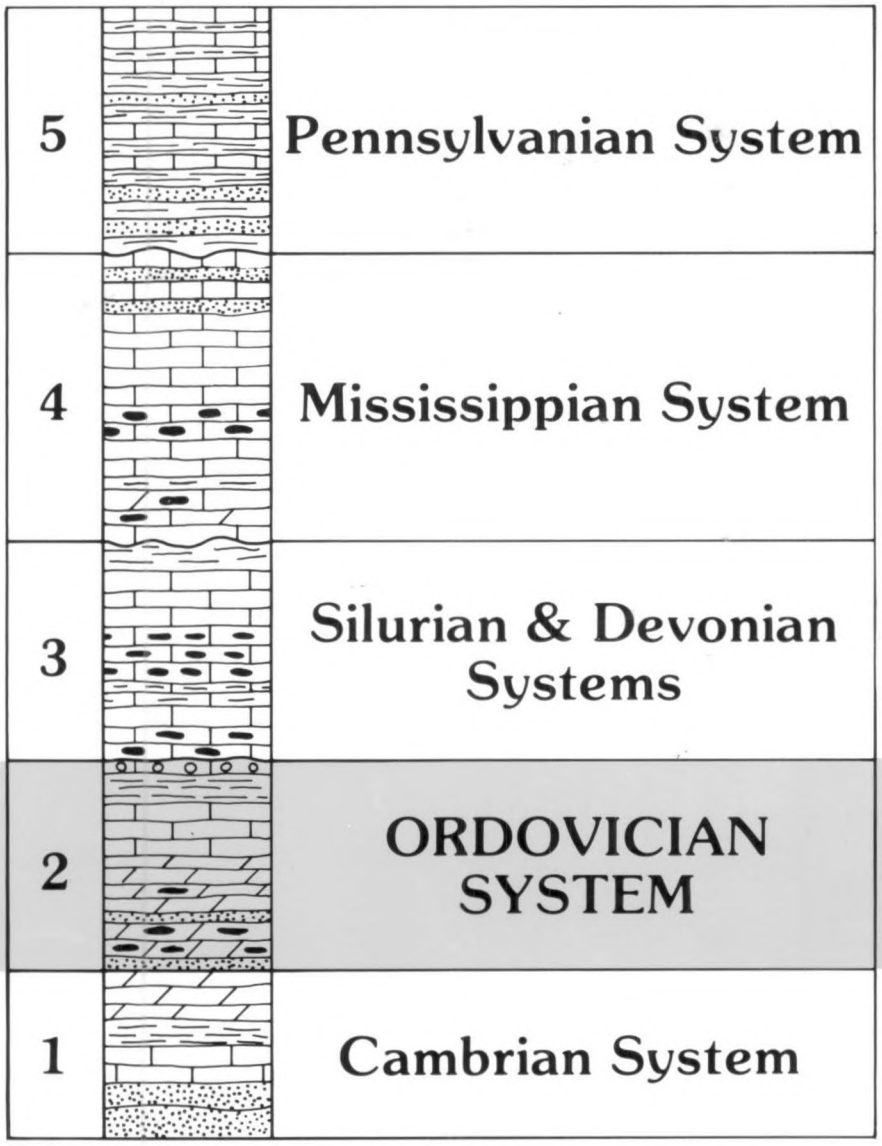
Report of Investigation No. 70

PALEOZOIC SUCCESSION IN MISSOURI

Part 2
ORDOVICIAN SYSTEM

by
Thomas L. Thompson



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1991

PALEOZOIC SUCCESSION IN MISSOURI
Part 2
ORDOVICIAN SYSTEM

by
Thomas L. Thompson

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CONTENTS

+ = Units new or redefined in Missouri formal stratigraphic nomenclature since 1961
* = Units not formally recognized in Missouri

LIST OF ILLUSTRATIONS

Formally recognized rock-stratigraphic units of the ORDOVICIAN SYSTEM in Missouri.

CINCINNATIAN SERIES

Northeastern Missouri	**Southeastern Missouri**
Edgewood Group	
Noix Limestone	Leemon Formation
Cyrene Limestone	
Maquoketa Shale	*Maquoketa Group*
	Girardeau Limestone
	Orchard Creek Shale
	Thebes Sandstone
	Cape La Croix Shale
	Cape Limestone

MOHAWKIAN SERIES

Kimmswick Limestone
- "upper Kimmswick Limestone"
- "lower Kimmswick Limestone"
  - House Springs K-bentonite bed

Decorah Group
- Guttenberg Limestone
- Kings Lake Limestone
- Spechts Ferry Formation
  - Glencoe Shale Member
    - Millbrig K-bentonite bed
  - Castlewood Limestone Member
    - Diecke K-bentonite bed

Plattin Group (Plattin Limestone)
- Macy Limestone
  - Zell Member
  - Hook Member
- Hager Limestone
  - Victory Member
  - Hely Member
  - Glaize Creek Member
- Beckett Limestone
- Bloomsdale Limestone
  - Establishment Shale Member
  - Brickeys Member
  - Blomeyer Member (southeastern Missouri only)
- "Pecatonica Formation" (southeastern Missouri only)
  - Medusa Limestone Member
- Joachim Dolomite
  - "upper Joachim Dolomite"
  - Metz Member
  - Matson Member
  - "middle Joachim Dolomite"
  - Defiance Member
  - Boles Member
  - "lower Joachim Dolomite"
  - Augusta Member
  - Abernathy Member (southeastern Missouri only)
- Dutchtown Formation (southeastern Missouri only)

St. Peter Sandstone
Starved Rock Member
Tonti Member
Kress Member

WHITEROCKIAN SERIES

Everton Formation

CANADIAN SERIES

Smithville Dolomite
Powell Dolomite
Cotter Dolomite
Jefferson City Dolomite
Roubidoux Formation
Gasconade Dolomite
Gunter Sandstone Member

INTRODUCTION

This is the second of a five-part review of Paleozoic stratigraphic units identified in Missouri. It is intended to supplement stratigraphic information presented by Martin et al. (1961a), with more detailed information on original definitions, type sections, and history of nomenclature, and to provide locations of reference and study sections in the state. It is hoped that this work will serve both as a ready reference and as a field guide to the Ordovician System in Missouri. When completed, Report of Investigations 70 will include the following parts:

Part I	Cambrian System
Part II	Ordovician System
Part III	Silurian & Devonian Systems
Part IV	Mississippian System (published in 1986)
Part V	Pennsylvanian System

Since publication of the last comprehensive discussion of the Ordovician System in Missouri (Martin et al., 1961a), continuing studies of Ordovician strata in North America and in the Midcontinent region have developed a more precise classification of the time divisions (series) of the System, and of Ordovician rock formations in Missouri. Some changes are those of refined nomenclature; others are more precise and detailed redefinitions of stratigraphic units. Major revisions of Middle Ordovician rocks were proposed by Larson (1951) for Missouri and Templeton and Willman (1963) for the Illinois Basin and surrounding states (including eastern and southeastern Missouri); in studies of the Ordovician-Silurian boundary in northeastern and southeastern Missouri by Satterfield (1971), Amsden (1974), and Thompson and Satterfield (1975), which resulted in a revised classification of Late Ordovician strata; and, most recently, in a correlation chart of the Ordovician System in the United States (Ross et al., 1982). These reports have resulted in a classification of Missouri Ordovician rocks that differs somewhat from that presented in 1961, both in the physical concepts of rock-stratigraphic units and in their relationship to geologic time units.

This report proposes some major changes in the Mohawkian (Middle Ordovician) sequence of Missouri. "Rock Levee" is abandoned. The interval between basal Plattin and uppermost Joachim in southeastern Missouri, south of Perryville, is tentatively identified as **"Pecatonica,"** although this is subject to change with more study. The four formations proposed by Larson (1951) for the Plattin (**Bloomsdale, Beckett, Hager,** and **Macy Limestones**) are adopted for usage in Missouri Plattin studies, and one new concept, the **Hager Limestone,** comprising three members, the **Glaize Creek** (new name), **Hely**, and **Victory Members**, is defined. In addition, the definitions of Kimmswick and Decorah strata are expanded, as more units are now known to be present than described in 1961. Also, a new name is proposed for the previously unnamed lower shale of the Maquoketa Group in southeastern Missouri; the **Cape La Croix Shale**.

Divisions of the Ordovician System

Ross et al. (1982) have proposed to call the Lower Ordovician Series (formerly called the **Canadian Series**, from exposures in eastern Canada) the **Ibexian Series**, which they defined from a more complete sequence of strata in Utah. However, prior usage of "Ibex" by Budge and Sheehan (1980; **"Ibex Member of the Elle Springs Dolomite"**) and LeMone (1975; as a substage of lower Ordovician strata) most likely will cause **Canadian** to remain the name for this series, with the Ibex section serving as the North American standard for the Canadian Series (J. Miller, personal communication, 1986).

In response to redefinition of the upper boundary of the Middle Ordovician in the Ohio region and the inclusion of strata formerly classified as upper Middle Ordovician in the Upper Ordovician Series, Middle Ordovician strata (all formerly in the **Champlainian Series**) are now placed in the lower **Whiterockian Series** and the upper **Mohawkian Series** (fig. 1).

Two proposed major divisions of the Ordovician System (fig. 2) are important to North American Ordovician studies (Ross et al., 1982). The **British series**, or British Standard Section, comprises six series, from older to younger: the Tremadoc, Arenig, Llandvirn, Llandeilo, Caradoc, and Ashgill Series, which are not directly correlative with the **North American** Canadian, Whiterockian, Mohawkian, and Cincinnatian Series. As indicated by Ross et al. (1982),

WINSLOW (1894)	SCHUCHERT (1910)	ULRICH (1911 b)	RUEDEMANN (1930)	SCHUCHERT (1943)	TWENHOFEL et al. (1954)
	Cincinnatic: Richmondian	Ordovician: Cincinnatian	Cincinnatian	Cincinnatian	Cincinnatian: Gamachian
	Cincinnatic: Maysvillian				Cincinnatian: Richmondian
	Cincinnatic: Edenian				Cincinnatian: Maysvillian
					Cincinnatian: Edenian
	Ordovicic: Mohawkian	Ordovician: Mohawkian	Mohawkian	Champlainian: Mohawkian	Champlainian: Trentonian
					Champlainian: Black Riveran
	Stones Riveran	Chazyan	Chazyan	Champlainian: Chazyan	Champlainian: Chazyan
		Unnamed			
Siluran System: Ozark Series	Canadic	Canadian System	Canadian	Canadian	Canadian
	Ozarkic or Cambric Period	Ozarkian System			
		Cambrian System			

Figure 1. *History of development of Ordovician series and stages in Missouri.*

interest has increased regarding a world-wide chronological scheme for the Ordovician System. Ross et al. (1984, p. 505) stated, however, that the compilation of an Ordovician time scale, and "the dependent dating of all depositional and tectonic events" in the North American Ordovician,

> "...would be better served by reference to North American provincial series that by their fundamental nature reflect the geologic history of North America."

In addition, they remarked (p. 506) that reports by Bergström (1983) and Whittington et al. (1984)

> "...provide convincing reasons for avoiding use of British series in the classification of the North American Ordovician: (1) Definition and stratigraphic range of virtually all British series in their type areas are unclear and require additional study; (2) shelly faunas that characterize each of these series are endemic to their typical areas or are strangers to North America; (3) attempts to define the British Series, other than the Llanvirn, in terms of graptolite zones have in several cases been erroneous or based on unproved or unprovable assumptions. Even if one assumed that the graptolite definition was correct, it would only aid correlations between graptoliferous units and would be of little help in classifying the carbonate and silici-clastic units that dominate North American Ordovician; (4) conodonts have limited usefulness in trans-Atlantic correlation in a few levels in the Llandeilo, Caradoc, and Ashgill, but they are not likely to be of critical assistance in older strata; (5) in the DNAG chart [Decade of North American Geology, Ross et al., 1982] the Tremadoc-Arenig is formalized as early Ordovician, the Llanvirn-Llandeilo as middle, and the Caradoc-Ashgill as late Ordovician, a course at odds with British practice, at odds with American usage, and acceptable nowhere else in the world (with exception of a few French authors)."

Lespérance (1985, p. 839) stated,

> "Stages within the type Cincinnatian (Edenian, Maysvillian, and Richmondian) of Ohio and adjacent areas were established near the beginning of this century, but in 1910 a fourth Ordovician stage was proposed: the Gamachian (as Gamachian Series, of equal

Figure 1 (cont.)

COOPER (1956)	KAY (1960)	SWEET AND BERGSTROM (1976)	FISHER (1977)	ROSS et al. (1982)	PRESENT REPORT
Cincinnatian	Cincinnatian: Richmondian	Cincinnatian: Richmondian	Cincinnat: Gamachian	Cincinnatian: Gamachian	Cincinnatian: Hirnantian
			Richmondian	Richmondian	Richmondian
	Maysvillian	Maysvillian	Maysvillian	Maysvillian	Maysvillian
	Edenian	Edenian	Mohawkian: Barneveldian	Edenian	Edenian
Mohawkian: Trentonian	Trentonian: Cobourgian	Champlainian: Cobourgian	Cobourgian		
	Shermanian	Shermanian	Turinian	Mohawkian: Shermanian	Mohawkian
	Rocklandian	Kirkfieldian		Kirkfieldian	
		Rocklandian		Rocklandian	
	Black Riveran	Black Riveran		Black Riveran	
Whiterockian	Chazyan: Valcouvian	Chazyan	Champlainian: Montyan	Whiterockian	Whiterockian
	Crownian				
	Dayan	Whiterockian	Whiterockian		
	Whiterockian				
Canadian	Canadian	Canadian	Canadian	Ibexian	Canadian

BRITISH STANDARD SERIES	NORTH AMERICAN STANDARD SERIES	
	Series	Stages
Ashgillian: Hirnantian, Rawtheyan, Cautleyan, Pusgillian	Cincinnatian	Gamachian (Hirnantian), Richmondian, Maysvillian, Edenian
Caradocian	Mohawkian	Shermanian, Kirkfieldian, Ricklandian, Black Riveran
Llandeilian	Whiterockian	
Llanvirnian		
Arenigian	Ibexian (Canadian)	
Tremadocian		

Figure 2. *Comparison of British Standard series and North American Standard series of the Ordovician System (from Ross et al., 1982, and Amsden, 1986).*

rank to the Richmondian) (Schuchert and Twenhofel 1910). The stratotype of the Gamachian is the Ellis Bay Formation of Anticosti Island; it was originally conceived to be younger than the Anticostian. Lespérance and Sheehan (1976) erroneously attributed the name Gamachian to Twenhofel (1928). Usage of the term Gamachian has been sporadic since 1928, and its revival is mainly due to recent conodont investigations (McCracken and Barnes 1981).

"Stages within the type Ashgillian of the United Kingdom had a checkered history; the latest revision (Ingham and Wright 1970) has apparently stabilized matters. Stages now recognized are, in ascending order, Pusgillian, Cautleyan, Rawtheyan, and Hirnantian. The Hirnantian was first proposed by Bancroft (1933) and is thus a junior synonym of Gamachian (Lespérance and Sheehan 1976). Both terms refer, however, to distinct provincial faunas, and as such may have their usefulness."

Acknowledgments

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Special thanks are due to Susan C. Dunn for both her excellent work in drafting the illustrations and for developing and completing the final layout for this report. Gary Clark assisted in the initial stages of layout preparation, Billy G. Ross labeled the photographs, and Betty Harris reviewed the text during the late stages of preparation. The editorial review was made by Robert H. Hansman, and the final overall review was done by Jerry D. Vineyard.

ORDOVICIAN SYSTEM

Lapworth, 1879

Original description -- (Lapworth, 1879, p. 14) "Here ... have we the hint for the appropriate title for the central system of the Lower Palaeozoics. It should be called the ORDOVICIAN SYSTEM, after the name of this old British tribe [*Ordovices*].

"...If there is anything specially becoming in commemorating the warlike tribe of the Silures in the name of a geologic system, how strikingly appropriate is the title of *Ordovician* in erecting a similar scientific monument to the last and most valiant of the old Cambrian tribes.

"On this arrangement the Lower Palaeozoic Rocks of Britain stand as follows:--

(c) SILURIAN SYSTEM:-- Strata comprehended between the base of the *Old Red Sandstone* and that of the *Lower Llandovery*.

(b) ORDOVICIAN SYSTEM:-- Strata included between the base of the *Lower Llandovery* formation and that of the *Lower Arenig*.

(a) CAMBRIAN SYSTEM:-- Strata included between the base of the *Lower Arenig* formation and that of the *Harlech Grits*."

Type locality -- In the Arenig Mountains and eastward across the Bala district of northern Wales.

Remarks -- Ordovician rocks in Missouri have traditionally been divided into three series (Martin et al., 1961a): the Canadian (Lower), Champlainian (Middle), and Cincinnatian (Upper) Series. Previous classifications contained as many as five series (Kay, 1960); the Middle Ordovician, for example, was represented by the Chazyan, Blackriveran, and Trentonian Series (fig. 1). In a recent study Ross et al. (1982) again revised the Ordovician System in North America, and proposed a four-part division. From oldest to youngest, this revised Ordovician System comprises the **Canadian Series** (called the **Ibexian Series** by Ross et al.), **Whiterockian Series**, **Mohawkian Series**, and **Cincinnatian Series**. The Whiterockian and Mohawkian constitute what was previously called the **Champlainian Series**. The series classification proposed by Ross et al. is presented herein for the Ordovician System in Missouri. In the following table, that classification is compared to the one used by Martin et al. (1961a):

1961	Present
Cincinnatian Series	Cincinnatian Series
Champlainian Series	Mohawkian Series
	Whiterockian Series
Canadian Series	Canadian Series

This new classification has not been "cast in concrete," but the consortium of 28 authors, not all of whom, however, necessarily agree with all recommendations in the report by Ross et al. (1982), has recommended that each organization or region adopt it in full or in part as individual needs dictate. The new concepts are described in detail herein, under discussions of the individual Ordovician series. Figure 3 is a chart comparing stratigraphic terminology of the Ordovician System in Missouri, as used by Martin et al. (1961a), to that presented herein.

In Missouri, Ordovician strata crop out over much of the state (fig. 4). They are primarily carbonates, with the notable exceptions of the St. Peter Sandstone and the Maquoketa Shale. Much of the Lower Ordovician (Canadian) is dolomite and cherty dolomite. The Middle Ordovician, excluding the St. Peter Sandstone,

MARTIN et al. (1961a)			PRESENT REPORT			
Series	Stage	Formation	Series	Stage	Formation	
			Cincinnatian	Hirnantian	Leemon (Noix Ls.) Formation	
					Maquoketa Gp	Girardeau Limestone
Cincinnatian	Richmondian	Orchard Creek (?) Formation		Richmondian		Orchard Creek Shale
		Thebes Formation				Thebes Sandstone
		Maquoketa Formation				Cape La Croix Shale
		Cape ("Fernvale") Formation		Edenian	Cape Limestone	
Champlainian	Mohawkian	Kimmswick Formation	Mohawkian		Kimmswick Limestone	
		Decorah Formation			Decorah Gp	Guttenberg Limestone
						Kings Lake Limestone
						Spechts Ferry Formation (*Glencoe Sh Member*, *Castlewood Ls Member*)
		Plattin Formation			Plattin Gp	Macy Limestone (*Zell Member*, *Hook Member*)
						Hager Limestone (*Victory Member*, *Hely Member*, *Glaize Creek Member*)
						Beckett Limestone
						Bloomsdale Limestone (*Establishment Sh. Mbr.*, *Brickeys Member*)
		Rock Levee Formation			"Pecatonica Formation"	
	Chazyan	Joachim Formation			Joachim Dolomite (Glenwood)	
		Dutchtown Formation			Dutchtown Formation	
		St. Peter Formation			St. Peter Ss. (*Strvd. Rock Mbr.*, *Tonti Member*)	
		Everton Formation	Whiterockian Series		Everton Formation	
Canadian		Smithville Formation	Canadian		Smithville Dolomite	
		Powell Formation			Powell Dolomite	
		Cotter Formation			Cotter Dolomite	
		Jefferson City Formation			Jefferson City Dolomite	
		Roubidoux Formation			Roubidoux Formation	
		Gasconade Formation			Gasconade Dolomite (*Gunter Ss Member*)	

Figure 3. *Comparison of nomenclature of Ordovician formations in Missouri presented by Martin et al. (1961a) to that of the present report.*

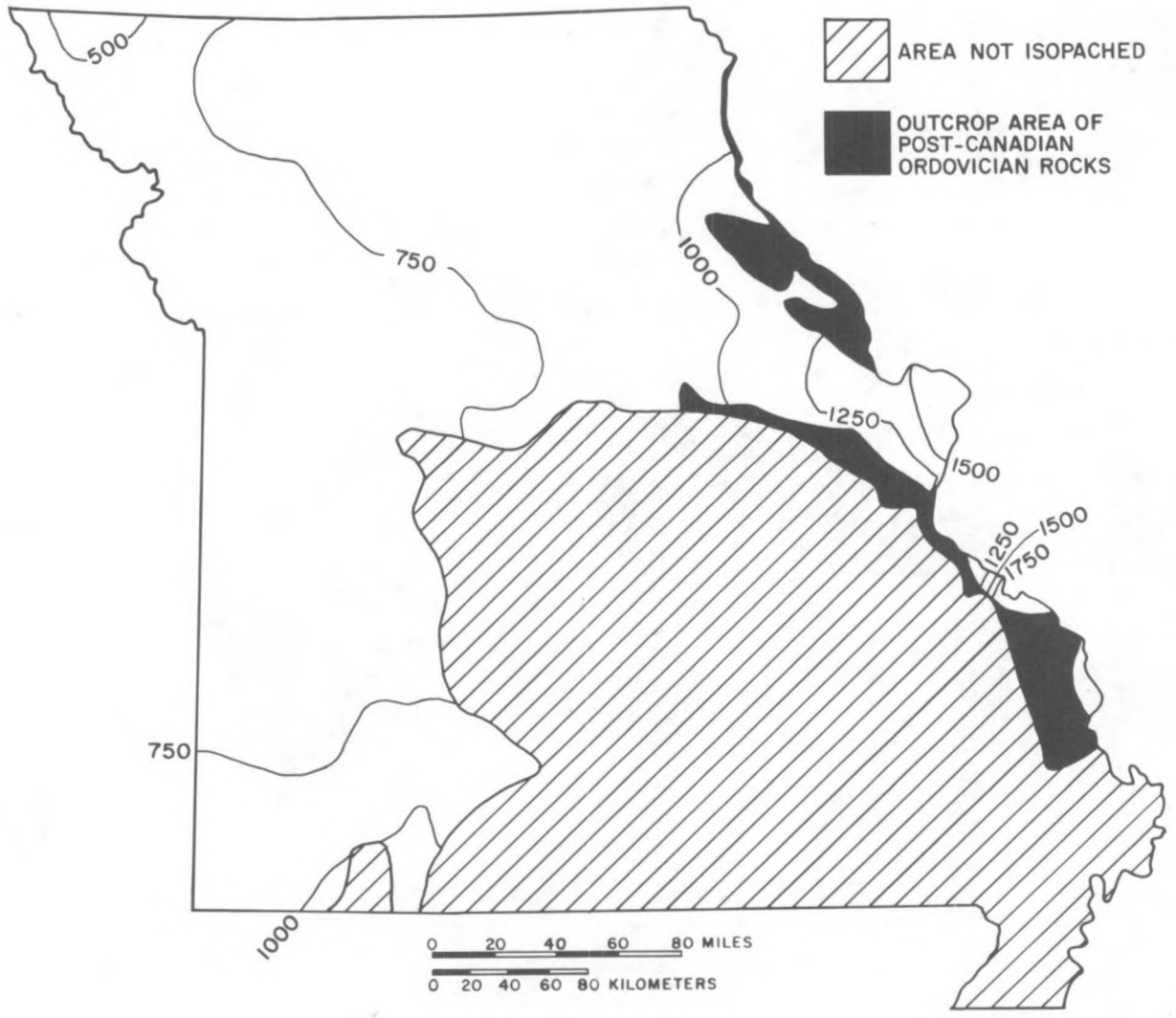


Figure 4. *Isopach map of the* **Ordovician System** *in Missouri showing areas of outcrop of Ordovician strata. Area not isopached has Canadian or older rocks at the surface. The Mississippi embayment (Bootheel region) does not have enough well data to isopach. Isopach interval is 250 ft.*

is mostly limestone and dolomite. The Upper Ordovician is mostly shale (Maquoketa), with associated thin limestones and minor sandstone.

Several major Paleozoic erosional episodes removed topmost Ordovician rocks in Missouri; (1) post-Canadian--pre-Whiterockian, (2) post-Whiterockian--pre-Mohawkian, (3) post-Mohawkian--pre-Cincinnatian, (4) post-Silurian--pre-Devonian, (5) post-Early Devonian--pre-Middle Devonian, (6) post-Late Devonian--pre-Mississippian, and (7) post-Late Mississippian--pre-Pennsylvanian. Figure 5 is a geologic map of the top of the Ordovician System in Missouri, reflecting these and post-Paleozoic to Recent erosional episodes.

Figure 4 is an isopach map of the Ordovician System in Missouri, showing the region of outcrop of Ordovician rocks, and figure 6 shows locations of type sections of Ordovician formations and members named in Missouri.

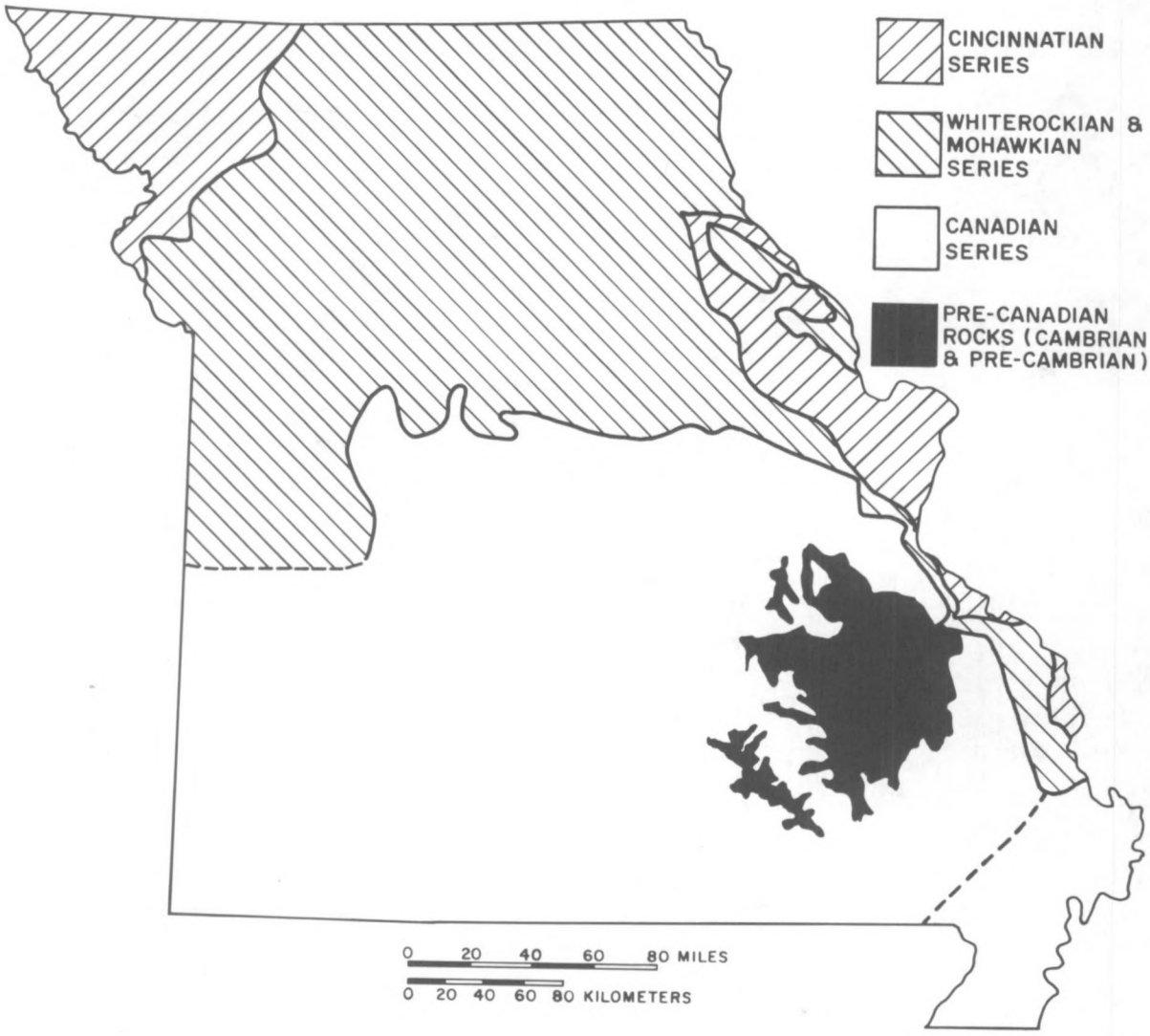
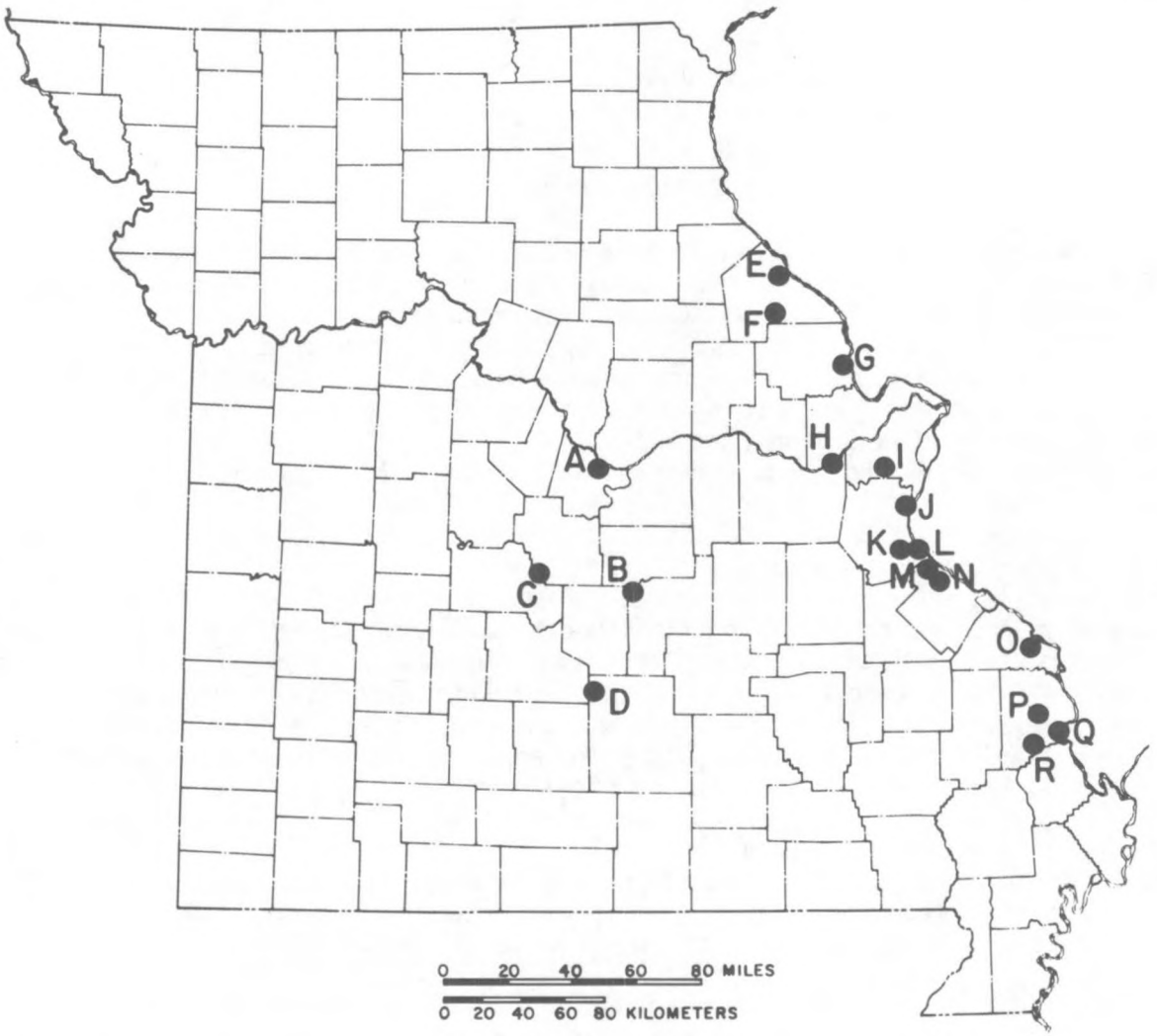


Figure 5. *Geologic map of the top surface of the Ordovician System in Missouri.*



(A) Jefferson City Dolomite
(B) Gasconade Dolomite
(C) Gunter Sandstone Member of Gasconade Dolomite
(D) Roubidioux Formation
(E) Noix Limestone
(F) Cyrene Limestone
(G) Kings Lake Limestone
(H) Matson Member of Joachim Dolomite
(H) Boles Member of Joachim Dolomite
(H) Defiance Member of Joachim Dolomite
(H) Augusta Member of Joachim Dolomite
(I) Glencoe Shale Member of Spechts Ferry Formation
(I) Castlewood Limestone Member of Spechts Ferry Formation
(J) Kimmswick Limestone
(J) Glaize Creek Member of Hager Limestone
(K) Joachim Dolomite
(L) Plattin Group
(M) Brickeys Member of Bloomsdale Limestone
(N) Macy Limestone
(N) Bloomsdale Limestone
(N) Beckett Limestone
(N) Zell Member of Macy Limestone
(N) Establishment Shale Member of Bloomsdale Limestone
(N) Hook Member of Macy Limestone
(O) Hager Limestone
(P) Leemon Formation
(Q) Girardeau Limestone
(Q) Cape La Croix Shale
(Q) Cape Limestone
(Q) Hely Member of Hager Limestone
(R) Dutchtown Formation
(R) Abernathy Member of Joachim Dolomite

Figure 6. *Map showing locations of type sections for Ordovician formations and members named in Missouri.*

CANADIAN SERIES

Dana, 1874; Ulrich, 1911b

Original description -- (Ulrich, 1911b, p. 647) "To the Canadian system I refer all deposits that on the one side can be shown, or which are believed, to be younger than the last of the Jefferson City dolomite in Missouri and the Shakopee in the upper Mississippi Valley, and which on the other side are thought to be older than the first sandstone and limestone (Everton) of the Saint Peter series in northern Arkansas. In other words, the Canadian embraces the wide interval that began with the first advance of the sea following the closing withdrawal of the Ozarkian seas, and which ended with the last emergence preceding the first or Saint Peter advance of the Ordovician waters."

(p. 648) "As originally defined by Dana in 1875 and as employed since by myself and other authors, the term Canadian was applied to the middle one of three divisions of the Lower Silurian. Beneath the Canadian, which included the Quebec group of Canada and the Calciferous and Chazy of New York, came the Primordial period; above it the Trenton period."

Several geologists have recently proposed to replace the name "Canadian Series" with "Ibexian Series." Hintze (1982, p. 7) stated, "A number of factors combine to favor the selection of Lower Ordovician strata in the Ibex area of western Utah as best representing this time interval in the United States. First, and most important, is the abundance and diversity of taxa present including trilobites, conodonts, brachiopods, graptolites, cephalopods, and other forms. Secondly, documentation of the fossils and the rocks in which they occur is fairly complete and unambiguous; the strata are clearly located on geologic maps, and most of the fossil groups have been identified and described by specialists. Thirdly, exposures are excellent and easily accessible by car. All are on public land; access is unrestricted, and the dry climate of the area makes collecting possible at almost any time of the year.

"Strata in the Ibex area include a continuous sequence of trilobite and conodont (and, more intermittently, brachiopod, nautiloid, and graptolite) faunas that range from Upper Cambrian through Middle Ordovician. The Cambrian-Ordovician boundary has recently been discussed by Taylor and Miller (1981) and, following current North American practice, placed at the base of the *Missisquoia* trilobite Zone, here located in the uppermost limestone beds of the North Peak Formation. The overlying Pogonip Group, divided into six formations by Hintze (1951, 1973), includes both Lower and Middle Ordovician faunas. The base of the Whiterockian in the Ibex area has been placed within the Wah Wah Limestone at the lowest occurrence of *Orthambonites subalata*, regarded by some as the lowest representative here of Cooper's (1956) *Orthidiella* Zone. *Orthidiella*, itself, occurs slightly higher in the Ibex section -- at the base of the Kanosh Shale (Jensen, 1967)."

Type locality -- The Canadian Series was named from discontinuous exposures in eastern Canada; the Ibexian Series (Ross et al., 1982), from a sequence of more complete exposures in the Ibex Hills of west-central Utah.

History of nomenclature

1873	Broadhead	Ozark series
1874	**Dana**	**Canadian series**
1876	Williams	Silurian system (upper part)
1891	Broadhead	Ozark series (upper part)
1893	Nason (a)	Ozark series (upper part)
	Nason (b)	"magnesian series"
1894	Winslow	Ozark stage of lower Silurian system (upper part)
	Hovey	Lower Magnesian series (Ozark series of Broadhead; upper part)
1899	Clark and Schuchert	Beekmantown (Beekmantownian)
1905	**Adams (*in* Adams and Ulrich)**	**Canadian series (lower part)**

1906	Bain	Prairie du Chien
1908	Buckley	Upper Cambrian System (upper part)
1910	Schuchert	Canadic Period
		Ozark or Cambric Period (upper part)
1911	Ulrich (a)	Stones River rocks (?)
	Ulrich (b)	**Canadian system (Jefferson City ? - Powell)**
		Ozarkian system (upper part)
1913	Lee	Upper Cambrian system (part; = upper Ozarkian and Canadian of Ulrich)
1915	Ulrich (*in* Ulrich and Bassler)	Canadian system (Roubidoux-Powell; unpublished manuscript)
		Ozarkian system (upper part; Gasconade)
1918	Tarr	Ordovician system (Canadian and upper Ozarkian of Ulrich)
	Branson	Ordovician system (Canadian series; lower part)
	Dake	Cambrian system (upper part)
1921	Dake	Beekmantown system (Roubidoux-Powell)
		Ozarkian system (Gasconade)
1922	Wilson	Canadian or early Ordovician system (Roubidoux-Powell)
		Ozarkian or late Cambrian system (upper part)
1926	Missouri Geological Survey	Ordovician system (lower part; "Canadian of Ulrich"; on Geologic map)
		Cambrian system (upper part; "Ozarkian of Ulrich")
1927	Edson	Beekmantown (Ozarkian) group
1928	Weller and St. Clair	Ordovician system (lower part; "Canadian of Ulrich")
		Cambrian system (upper part; "Ozarkian of Ulrich")
	Folger	Beekmantown group
1931	McQueen (a, b)	Canadian system of Ulrich
		Ozarkian system of Ulrich (upper part)
1933	Branson and Mehl (b)	Lower Ordovician
1934	Shimer	Ozarkian (upper part)
1936	Ireland	Beekmantown (Canadian) (excluded Gasconade)
		Lower Ordovician (included Gasconade)
1937	Farrar and McManamy	Canadian system (of Ulrich; Powell only)
	Grohskopf and Hundhausen	Canadian system
		Ozarkian system (upper part)
1938	McQueen and Greene	Canadian system (lower part)
		Ozarkian system
	Ulrich and Cooper	Canadian Period (Roubidoux-Smithville)
		Ozarkian Period (upper part; Gasconade)
1939	Ulrich	"upper Canadian"
	Grohskopf et al.	Canadian system of Ulrich
		Ozarkian system of Ulrich (upper part)
1941	Keyes	Yellvillian series of Cambric Period
		Ozarkian series of Cambric Period
1947	Miller et al.	Lower Ordovician
1949	Freeman	Canadian
1951	Beveridge	Canadian series
1954	Twenhofel et al.	Canadian series **(as presently defined)**
1955	McCracken	"upper Arbuckle"
1957	Flower	Canadian system
		Cassinian series
		Jeffersonian series

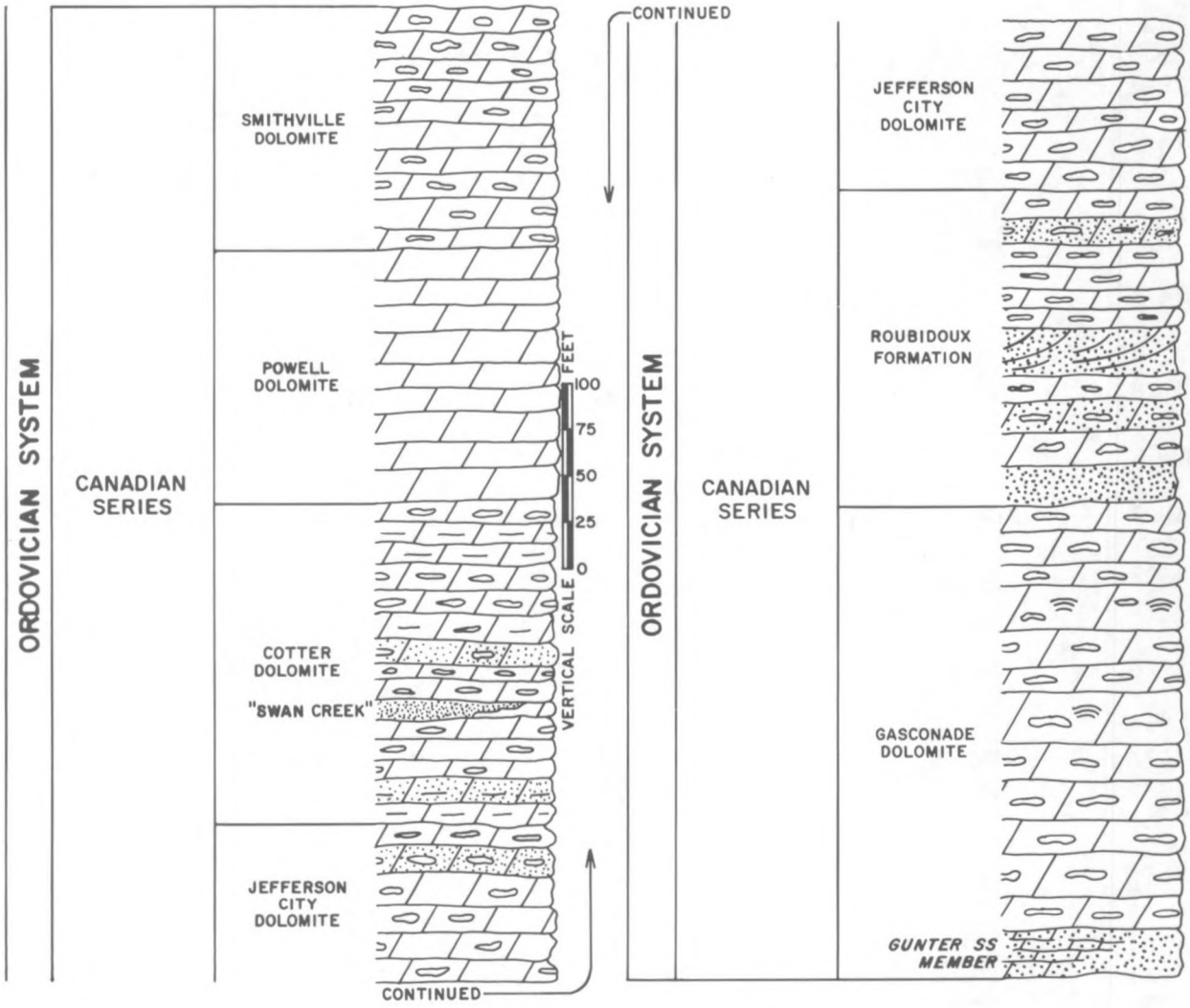


Figure 7. *Generalized columnar section of formations of the* **Canadian Series** *in Missouri. Adapted from Martin et al. (1961a).*

		Demingian series
		Gasconadian series
1961	Martin et al. (a)	Canadian Series (Gasconade-Smithville)
	Swann and Willman	Knox Megagroup (upper Mississippi Valley; part; may include Everton)
1975	Oros et al.	Arbuckle
1982	Ross et al.	Ibexian Series
1986	Stinchcomb	Lower Ordovician (Canadian)
1991	**Thompson (present report)**	**Canadian Series**

Remarks -- Defined by Ulrich (1911b) as a time unit younger than the Ozarkian Series and beneath the Middle Ordovician (fig. 1), the **Canadian Period** (or Series) comprised Roubidoux-Powell or Jefferson City-

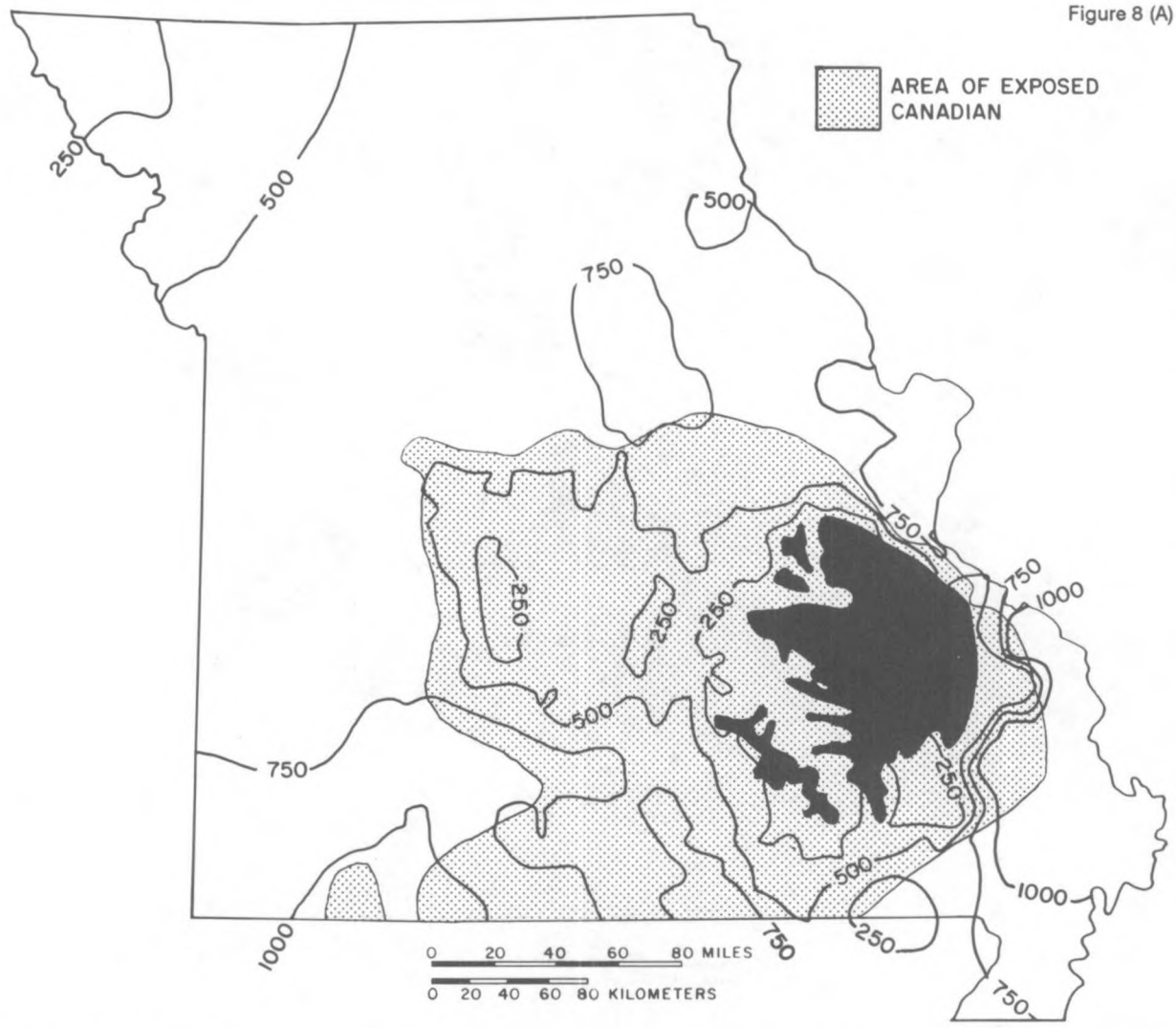


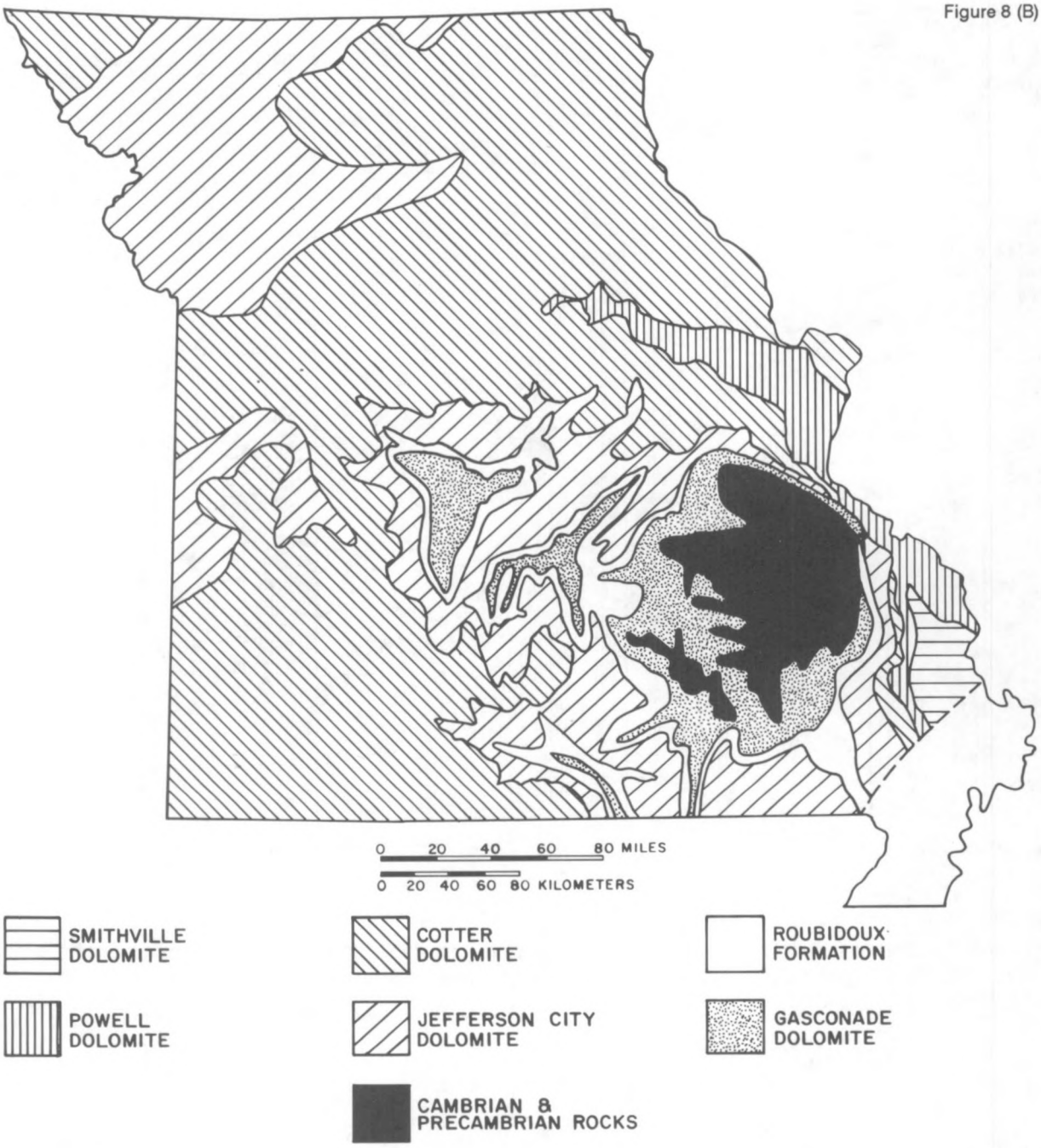
Figure 8. *The* **Canadian Series** *in Missouri:* **Map A** *- isopach map, distribution, and areas of outcrop. Isopach interval is 250 ft.* **Map B** *- generalized geologic map of the top of the Canadian surface in Missouri.*

Powell strata, usually the former. The Gasconade was the uppermost formation of the Ozarkian Period (or Series). Eventually, Canadian became the accepted standard for the Lower Ordovician in North America, and was redefined to include the Gasconade within its base. "Ozarkian" was abandoned, but Ross et al. (1982, p. 5) stated,

> "... the Canadian lacks a single type or reference section and has been held together by expediency. Because the record of this early Ordovician time is superbly recorded in the Ibex Hills of west central Utah, the Ibexian Series is proposed to replace the Canadian. It is recognized that tradition will persuade many to hold onto the older term, but the demands of modern biostratigraphy will eventually require that the Ibex section becomes the standard reference."

Ross et al. (1982) proposed to redefine the lower Ordovician in North America as the **Ibexian Series**, based on exceptionally complete exposures in western Utah. According to Hintze (1982, p. 10),

Figure 8 (B)


0 20 40 60 80 MILES
0 20 40 60 80 KILOMETERS
SMITHVILLE DOLOMITE
POWELL DOLOMITE
COTTER DOLOMITE
JEFFERSON CITY DOLOMITE
CAMBRIAN & PRECAMBRIAN ROCKS
ROUBIDOUX FORMATION
GASCONADE DOLOMITE

"Strata in the Ibex area record uninterrupted miogeosynclinal deposition from Late Cambrian into Middle Ordovician time. The beds contain an unusually complete and diverse representation of Lower Ordovician fossils. The range of overlap with fossiliferous Upper Cambrian and Middle Ordovician strata permits the identification of time boundaries from a selection of zonal possibilities."

The Ibex section will most likely become the standard reference section for the Lower Ordovician (Canadian Series) throughout North America. However, because the name "Ibex" has been previously proposed as a substage (LeMone, 1975) and as a member of the Elie Springs Dolomite (Budge and Sheehan, 1980), "Ibexian" is not available as a series name (J. Miller, personal communication, 1986).

The Canadian Series in Missouri (figs. 7 and 8) mostly consists of dolomite, sandy dolomite, cherty dolomite, and sandstone. Several well-developed sandstone beds in the Canadian sequence in Missouri are used as marker beds for surface and subsurface correlations. Recognition of chert types is very important for detailed correlations; some chert concentrations consist of silicified stromatolite mounds and beds. Formations have traditionally been recognized by the relative amounts of chert and sandstone, the type of dolomite, type of chert, etc. Formations of Canadian age presently recognized in Missouri are the following:

Smithville Dolomite
Powell Dolomite
Cotter Dolomite
*Jefferson City Dolomite
*Roubidoux Formation
*Gasconade Dolomite
*Gunter Sandstone Member
(* = named from Missouri exposures)

Canadian strata are present in the subsurface over much of northern and western Missouri, and crop out over a large part of the southern half of Missouri (fig. 4). The base of the series, marked in many areas by the Gunter Sandstone Member of the Gasconade Dolomite, has been described as unconformable, but recent studies have shown that the actual base of the Canadian (the Cambrian-Ordovician boundary) is not at the base of the Gasconade, but is in the upper part of the underlying Eminence Dolomite (Kurtz, 1981). The top of the series, marked by a regional unconformity, is represented by the Smithville Dolomite in parts of southeastern Missouri; by the Powell Dolomite in a slightly larger area of southeastern and east-central Missouri, and in southwestern Missouri; by the Cotter Dolomite in much of eastern, southern, southwestern, and central Missouri; and by the Jefferson City Dolomite in west-central and northwestern Missouri, where the Cotter was removed by pre-St. Peter erosion. Uppermost Canadian strata are, in turn, overlain by rocks of the Whiterockian Series in southeastern Missouri; the Mohawkian Series in east-central, northeastern, and central Missouri; and by post-Ordovician (Devonian or Mississippian) rocks in western, southwestern, and other regions of Missouri. The stratigraphic interval, Jefferson City through Smithville, is regarded as approximately equivalent to the **Beekmantown Group** of the Appalachian region, and to the **Knox Dolomite** of other regions.

The rock units of the Canadian in Missouri were considered sufficiently distinctive by Kay (1960; adapted from Flower, 1957) to define the following stages for the Canadian Series of New York:

Canadian Series
Cassinian Stage
Jeffersonian Stage
Demingian Stage
Gasconadian Stage

Fisher (1982) proposed to replace Demingian Stage with **Roubidouxan Stage**. Obviously, Jeffersonian, Roubidouxan, and Gasconadian were derived from the Missouri Lower Ordovician section.

An indication of the complexity of the Canadian rocks in Missouri can be seen in the discussion of the **Knox Group** in east-central states, rocks lithologically identical to, and the same age as, the Canadian and uppermost Cambrian rocks in Missouri. Wieg and Burns (1986) stated,

"The Cambro-Ordovician Knox Group consists of a thick succession of passive-margin peritidal dolomites. Petrographic analysis of core samples using diffuse transmitted light and blue-light fluorescence indicates that pelletoids, ooids, intraclasts, and algal laminae are common. Shelly skeletal material is scarce.

Dolomite is typically clear to CCCR zoned, and fabrics are xenotopic to idiotopic. Anhydrite and gypsum, not found in outcrop studies, are present as sabkha-type displacive nodules and as large replacement crystals. Quartz is found both as detrital grains and as an early- and late-stage replacement of evaporites as well as carbonates. Most samples are consistent with very early dolomitization, although uncommon relict spastoliths indicate fresh-water diagenesis may have occasionally preceded dolomitization. Crystallization of coarse argillaceous dolomites occurred before compaction...replacement dolomites are non-zoned to irregularly zoned...recrystallization (and chemical homogenization) accompanied burial. Late-stage pore filling dolomites, precipitating in voids from leached evaporites (?), have a finely zoned luminescence...Cross-cutting relationships of stylolites indicates most diagenetic events occurred before maximum burial. The presence of evaporites throughout shoal-water dolomites argues against the importance of freshwater dilution and imply sabkha analogies for subsurface water movement. The principal dolomitizing agent was normal to hypersaline seawater."

Gasconade Dolomite

Nason, 1892

Original description -- (Nason, 1892, p. 115) "... it is proposed that the name *Gasconade* limestone be applied to the great series of limestone beds interstratified with thin beds of sandstone, which underlie the Roubidoux sandstone."

Type section -- The Gasconade Dolomite was named from exposures in the bluffs along the Gasconade River, in Laclede, Pulaski, and Phelps counties, in central Missouri. A specific type section has not been designated.

Reference sections -- Approximately 130 ft of Gasconade and 65 ft of the overlying Roubidoux Formation are exposed in a southwest-facing bluff of the Gasconade River Valley, SW¼ NW¼ NW¼ sec. 31, T. 37 N., R. 10 W., Dixon 7½' Quadrangle, Pulaski County, south-central Missouri. The Roubidoux at this section was described in detail by Heller (1954, p. 94-96). He described the Gasconade as follows:

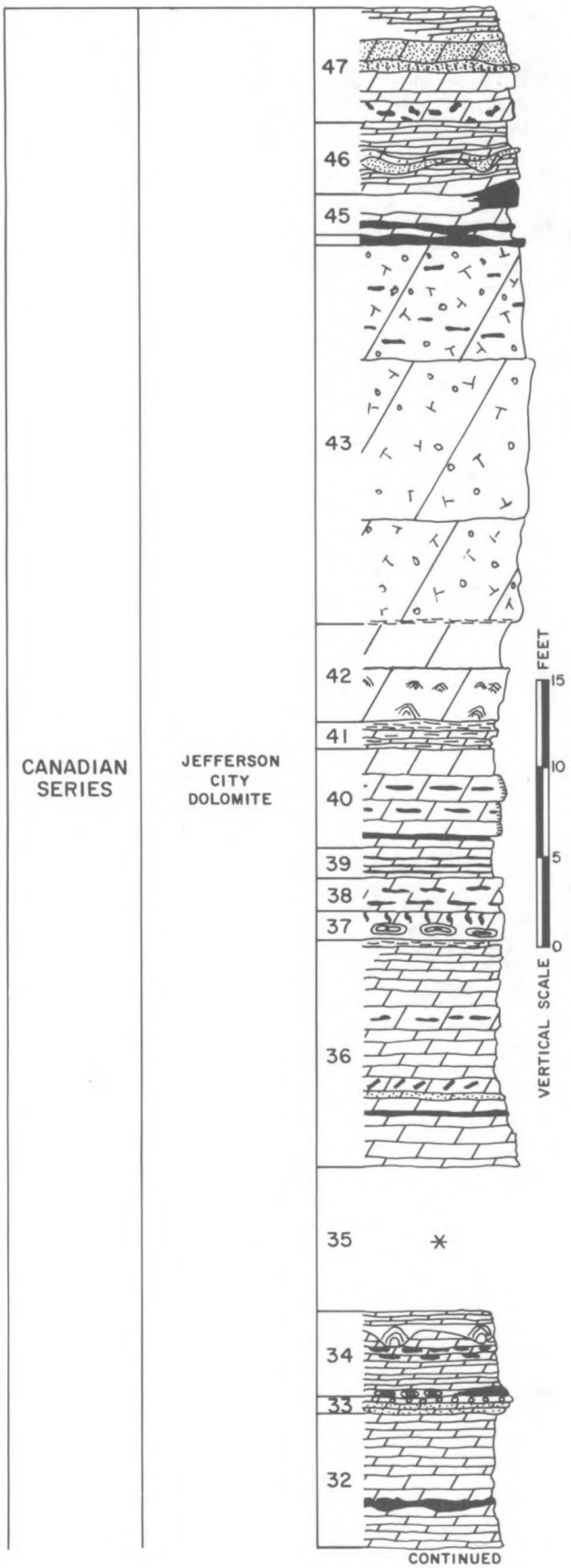
"Gasconade formation

1. Dolomite, coarse-grained, light gray, medium- to massive-bedded; weathers to massive, pitted surface. Upper 30 feet of unit relatively chert free.....130' "

The Gasconade is well-exposed in roadcuts on I-44 east of the bridge over Roubidoux Creek (figs. 9 and 10), NW¼ NW¼ SE¼ and NE¼ NE¼ SE¼ sec. 25, T. 36 N., R. 12 W., and NW¼ NW¼ SW¼ sec. 30, T. 36 N., R. 11 W., Pulaski County, Missouri (see "Reference sections" under **Roubidoux Formation**).

History of nomenclature

1855	Swallow	3rd Magnesian Limestone (upper part; Ste. Genevieve County)
		3rd Magnesian Sandstone (northwestern Missouri)
		4th Magnesian Limestone (part; Branson, 1944)
1873	Pumpelly	3rd Magnesian limestone (3rd sandstone)
1892	**Nason**	**Gasconade limestone**
		Roubidoux sandstone (locally = Gunter Sandstone Member)
1894	Winslow	Osage limestone
		Cole Camp sandstone
1896	Keyes	Leaver limestone (part)
1898	Keyes	3rd Magnesian limestone (3rd sandstone)
1900	Gallaher	1st Calciferous
		Roubidoux sandstone
1902	Weeks	Gasconade limestone



ORDOVICIAN SYSTEM - CANADIAN SERIES

Jefferson City Dolomite (75 ft)

Units 36-47 measured on north side of west-bound onramp.

47. Dolomite, cotton rock, sandy at top; irregular chert blebs in dolomite layer at base; siliceous sandstone near middle; to top of hill. (6.2 ft)
46. Dolomite, buff, medium-grained, medium-bedded at base, thin-bedded above channel; layer of siliceous sandstone in trough of channel. (3.2 ft)
45. Dolomite, buff, and chert, dark-gray with brown areas. (3.2 ft)
44. Chert, blue-gray, round and angular chert fragments in a siliceous oolite matrix. This chert layer intersects upper one-third west-bound onramp road. (0.3-0.6 ft)
43. Dolomite, smoky-gray, fine-grained, thick to massive-bedded, fucoidal, pitted, with quartz and/or calcite lining; fetid odor produced on crushing; upper unit has flat, white chert nodules and some blue-gray and white banded chert nodules ("**Quarry ledge**"). (20.7 ft)
42. Dolomite, gray, medium-grained, pitted, weathered surface shows light-brown areas, cryptalgal structure at base, has some features of "Quarry ledge." (5.4 ft)
41. Dolomite, blue-gray; shale at top; pinches out uphill; recessive. (1.2-1.7 ft)
40. Dolomite, gray, medium-grained, laminated; contains bands of chert and chert breccia. (5.4 ft)
39. Dolomite, as above, but with bands of chert. (1.6 ft)
38. Dolomite, blue-gray, weathers smoky-gray; pits with quartz druse and spar lining ("lower Quarry ledge"). (1.9 ft)
37. Dolomite, buff, medium-grained, local bulls-eye chert which has alternating bands of chert and dolomite; fragments of blue-gray chert at top. (1.5 ft)
36. Dolomite, light-gray, weathers smoky-gray, medium-grained; irregular areas of coarse-grained dolomite; uniform medium-bedding; 5% blue-gray and white chert layers; one layer of chert breccia; one sandy layer; green shale at top. (12.3 ft)
35. Covered, at green Saint Robert turnoff sign. (8 ft)

Units 30-34 measured from roadcut southeast of St. Roberts turn-off sign.

34. Dolomite, buff-weathering, lower third breaks down to shaly material; white-weathering chert in upper part and distinctively banded chert at base; cryptalgalaminated horizon at top. (1.0-1.6 ft)

Roubidoux Formation (133 ft)

33. Dolomite, light-gray, medium-grained, sandy; 0.3 ft siliceous oolite layer at top; scattered gray flat chert nodules. (1 ft)
32. Dolomite, gray, weathers tan (distinct from below) medium- to thin-bedded; fractured tripolitic chert layers in lower part ("**Buhrstone horizon**"). (7.4 ft)

Figure 9. **Gasconade Dolomite, Roubidoux Formation, and Jefferson City Dolomite** *exposed in a roadcut on I-44 west of the Saint Robert interchange, sec. 30, T. 36 N., R. 11 W., Waynesville 7½' Quadrangle, Pulaski County, Missouri. Adapted from a description by Beveridge and Aughenbaugh (1972).*

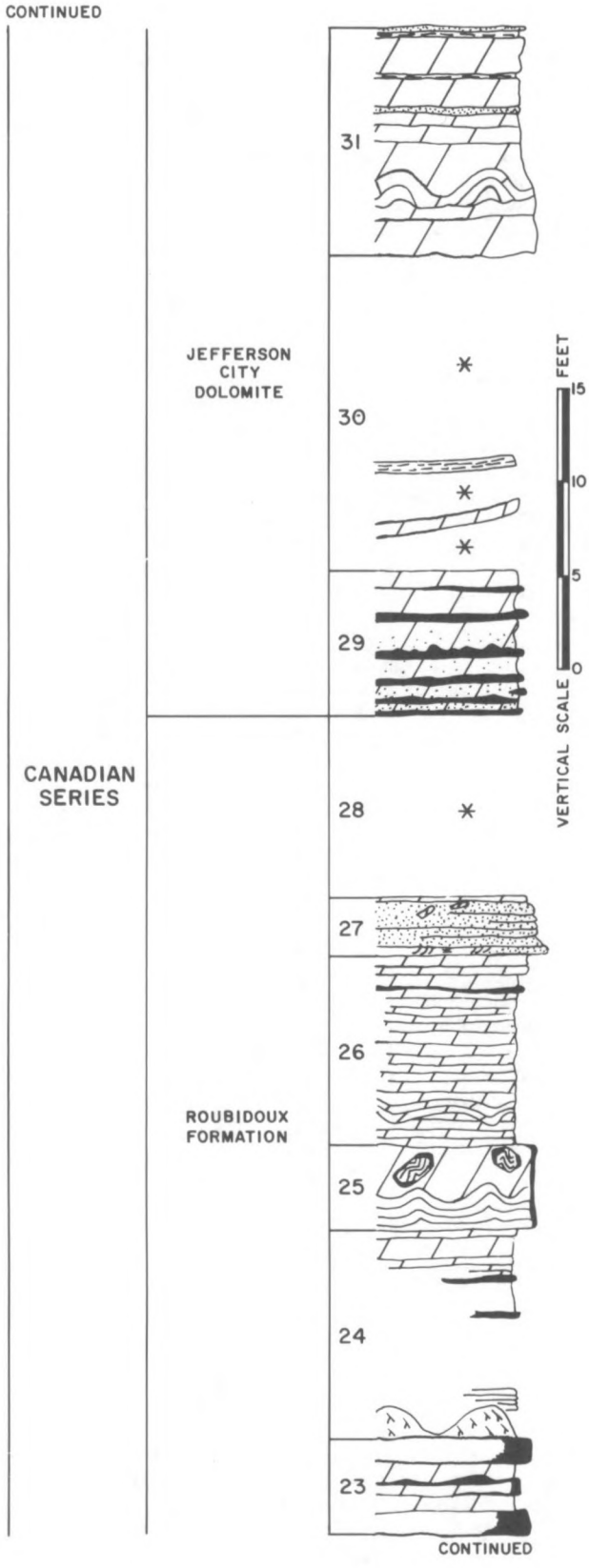


Figure 9 (cont.)

31. Dolomite, light-gray, weathers smoky-gray, medium-grained, thick- to thin-bedded; scattered spar-filled vugs, two green shale layers; one siliceous sandstone bed; cryptalgal structure in lower part. (12.1 ft)
30. Covered; in ravine across from "DeVille Motor Inn" sign. (16.5 ft)
29. Dolomite, light-gray, sandy toward base, alternating with chert layers and nodules, some being tripolitic; exposed only in ditch across highway from caution sign on west-bound lane. (7.5 ft)
28. Covered ravine. (11 ft)

Units 10-27 exposed in cut and ravine across highway and west from caution sign on west-bound lane.

27. Sandstone, brick-red below and white upper 1.7 ft; ripple-marked and mud-cracked; some red sandstone is quartzitic and cross-bedded; upper part contains doloclasts. (3.2 ft)
26. Dolomite, dull-brown with greenish-brown partings, thin-bedded; blue-gray or tripolitic chert nodules; top 1 ft medium bedded, harder. (9.9 ft)
25. Dolomite, siliceous in many places; cryptalgal structures. (4-4.5 ft)
24. Dolomite, thin-bedded, with blue-gray chert layers; 40-50% chert; not readily accessible; basal 3 ft coarse-grained, brown weathered dolomite with cryptalgal structures. (11 ft)
23. Chert, banded blue-gray with white surface, interbedded with brown, thin-bedded dolomite. (5.3 ft)

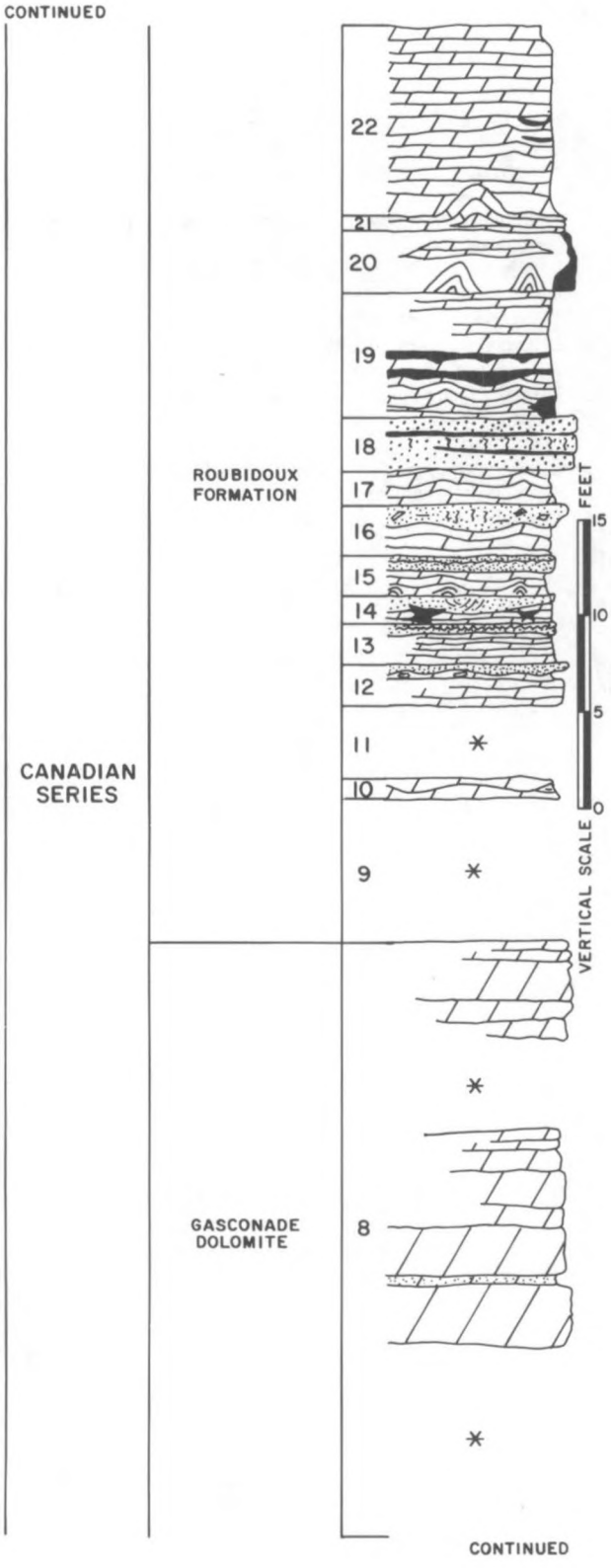


Figure 9 (cont.)

22. Dolomite, thin-bedded, beds locally siliceous; upper 1.5 ft darker, recessive. (9.5 ft)
21. Dolomite, cryptalgal; beds 20 and 21 form algal zone. (0.5-2.3 ft)
20. Chert, contains cryptalgal structures, locally grades into dolomite. (3 ft)
19. Dolomite, light-gray and buff, coarsely crystalline, thin- to medium-bedded; local chert layers; base locally siliceous or algal. (6.2 ft)
18. Quartzite, oolitic, light-gray to white, with thin, white chert layers. (2.8 ft)
17-12. Dolomite, tan and gray mottled, thin-bedded; contains white tripolitic chert masses; stromatolitic; alternating with thinner siliceous and ripple-marked sandstone. (11.7 ft).

Units 9-11 measured in drainage ditch at Saint Robert city limits sign.

11. Covered. (3.8 ft)
10. Dolomite, light-buff and gray, medium-grained; top knobby and mud-cracked; contains small white tripolitic chert masses.
9. Covered. (7.4 ft)

Units 4-8 along south edge of east-bound lane

Gasconade Dolomite (116 ft)

8. Several discontinuous exposures of dolomite, buff, coarsely crystalline, like top of unit 7 below; non-cherty "upper Gasconade Dolomite"; measured along the north side of the east-bound lane of I-44. (30.5 ft)

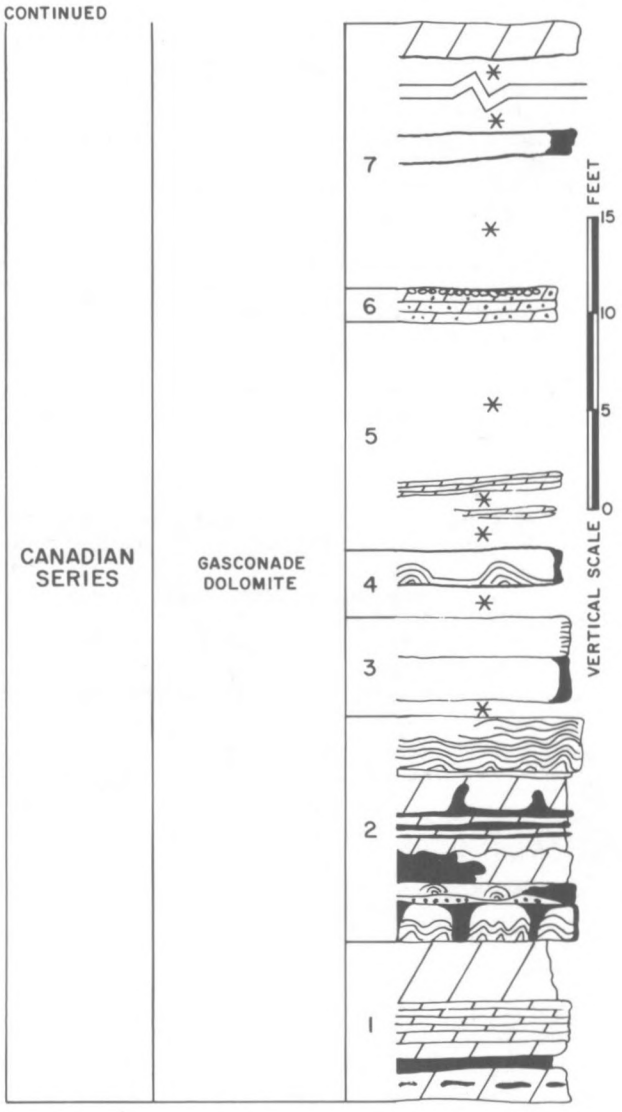


Figure 9 (cont)

7. Dolomite, buff, coarsely crystalline; sand-sized grains upper 2-3 ft of unit; and dolomite, siliceous, quartz-lined cavities; planispiral gastropods; 1-2 ft bed 10 ft above base; measured along north edge of east-bound lane; most of interval covered. (44.5 ft)
6. Dolomite, light-brown; 2-3 in. siliceous oolite bed at top; beds form a ledge in talus. (1.7 ft)
5. Mainly covered interval; several thin-bedded dolomite beds exposed in lower 5 ft. (11.5 ft)
4. Chert, gray and white banded, with dolomite mounds; in flat area between lanes. (3.5 ft)

Units 1-3 exposed on north side of west-bound lane of I-44 just east of bridge over Roubidoux Creek.

3. Chert, gray and white banded; bands flatter than those in unit 2. (5 ft)
2. Dolomite, tan, medium-grained, beds laterally replaced by chert; cryptalgalaminate beds at top and bottom. (11.2 ft)
1. Dolomite, lower ledge gray, upper ledge tan. (8 ft)

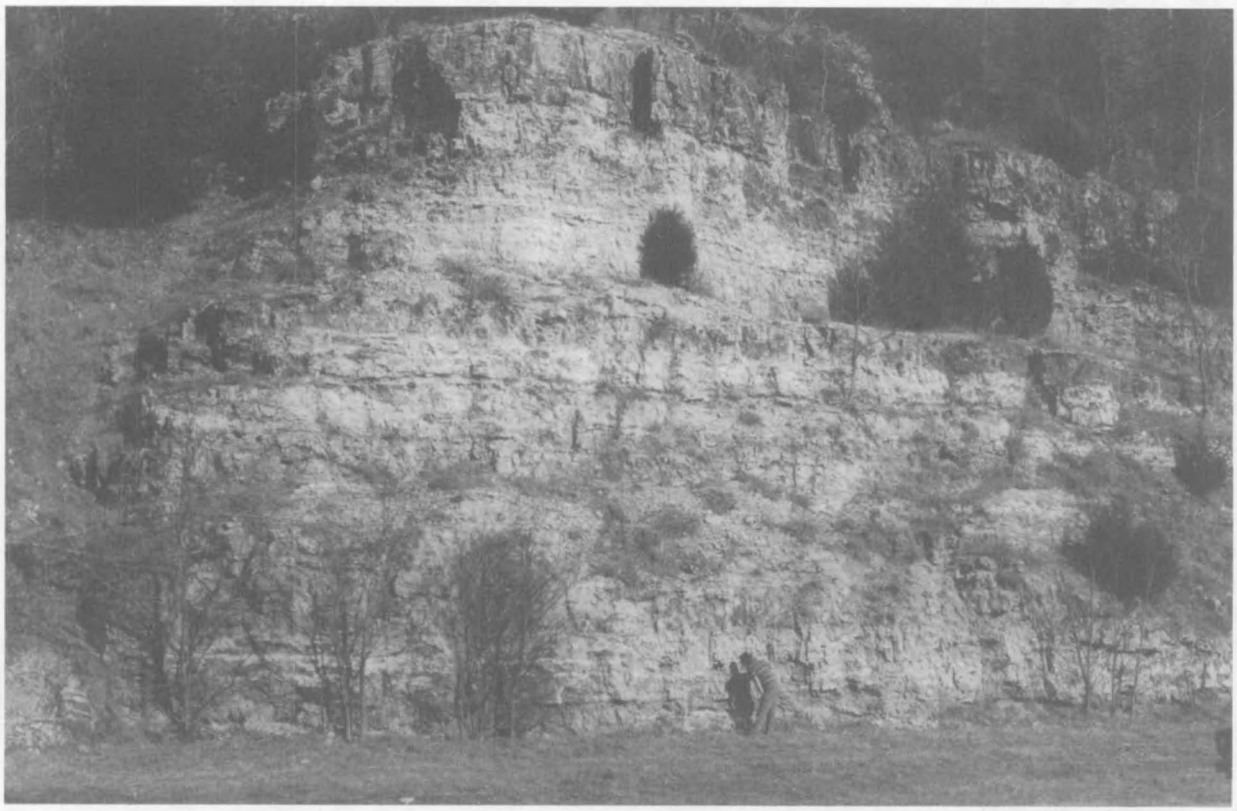


Figure 10. *Very cherty lower* **Gasconade Dolomite** *exposed in roadcut on I-44 near Roubidoux Creek, Pulaski County, Missouri (units 1-3, fig. 9). Photograph by T.L. Thompson.*

1903	Ball and Smith	Gasconade limestone Gunter sandstone
1929	McQueen	Gasconade formation Van Buren formation (1 member; Gunter sandstone)
1933	Branson and Mehl (a)	Gasconade Van Buren
	Oder	Knox dolomite (lower part)
1961	Martin et al. (a)	Gasconade formation (1 member)
1964	Harlton	McKenzie Hill Formation (in Oklahoma; "equivalent to Gasconade of Missouri")
1970	Kay	Gasconade Formation Van Buren Formation
1982	Ross et al.	Gasconade Dolomite
1986	Stinchcomb	Gasconade Formation
1991	**Thompson (present report)**	**Gasconade Dolomite (1 member)**

Remarks -- The Gasconade Dolomite consists predominantly of light-brownish-gray to brown, medium- to coarsely crystalline dolomite, finely crystalline dolomite, and cherty dolomite. The base is marked in many areas by a prominent sandstone or sandy dolomite (Gunter Sandstone Member). Gasconade strata are informally divided into a "lower" and "upper" Gasconade; separation is based primarily on amount and type of chert.

The **"lower Gasconade"** is medium- to finely crystalline dolomite (mudstone), characterized by varying amounts of chert that in many places may exceed 50 percent of the total volume of the rock. Thin to medium bedding characterizes much of the lower Gasconade Dolomite. In many places the top of the "lower

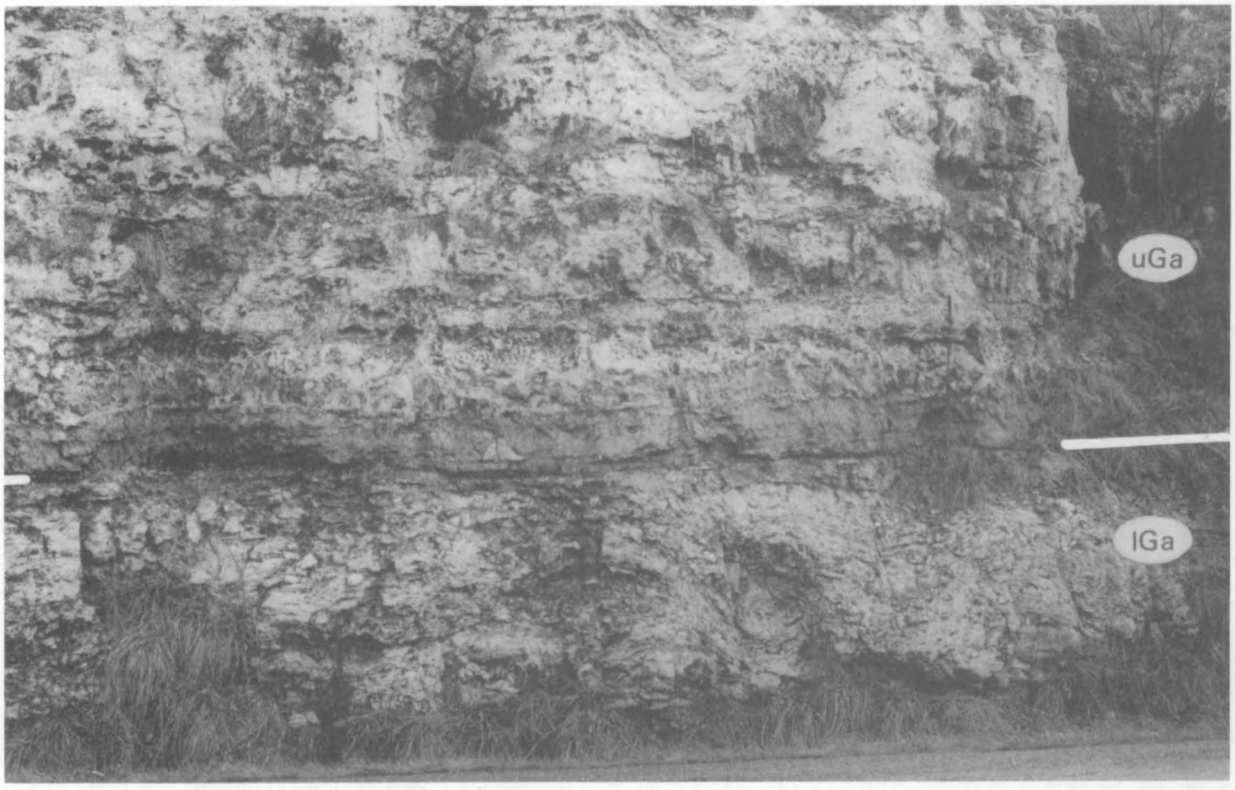


Figure 11 (A) ▲ Figure 11 (B) ▼

Figure 11. **(A)** *Stromatolitic zone separating upper* (**uGa**) *and lower* (**lGa**) *parts of the* **Gasconade Dolomite;** *roadcut on I-44, northwestern Phelps County, SW¼ SW¼ sec. 18, T. 37 N., R. 9 W., Newburg 7½' Quadrangle.* **(B)** *Silicified stromatolite weathered from stromatolitic zone at the top of the "lower* **Gasconade Dolomite**," *showing details of algal laminae. Photographs by T.L. Thompson.*

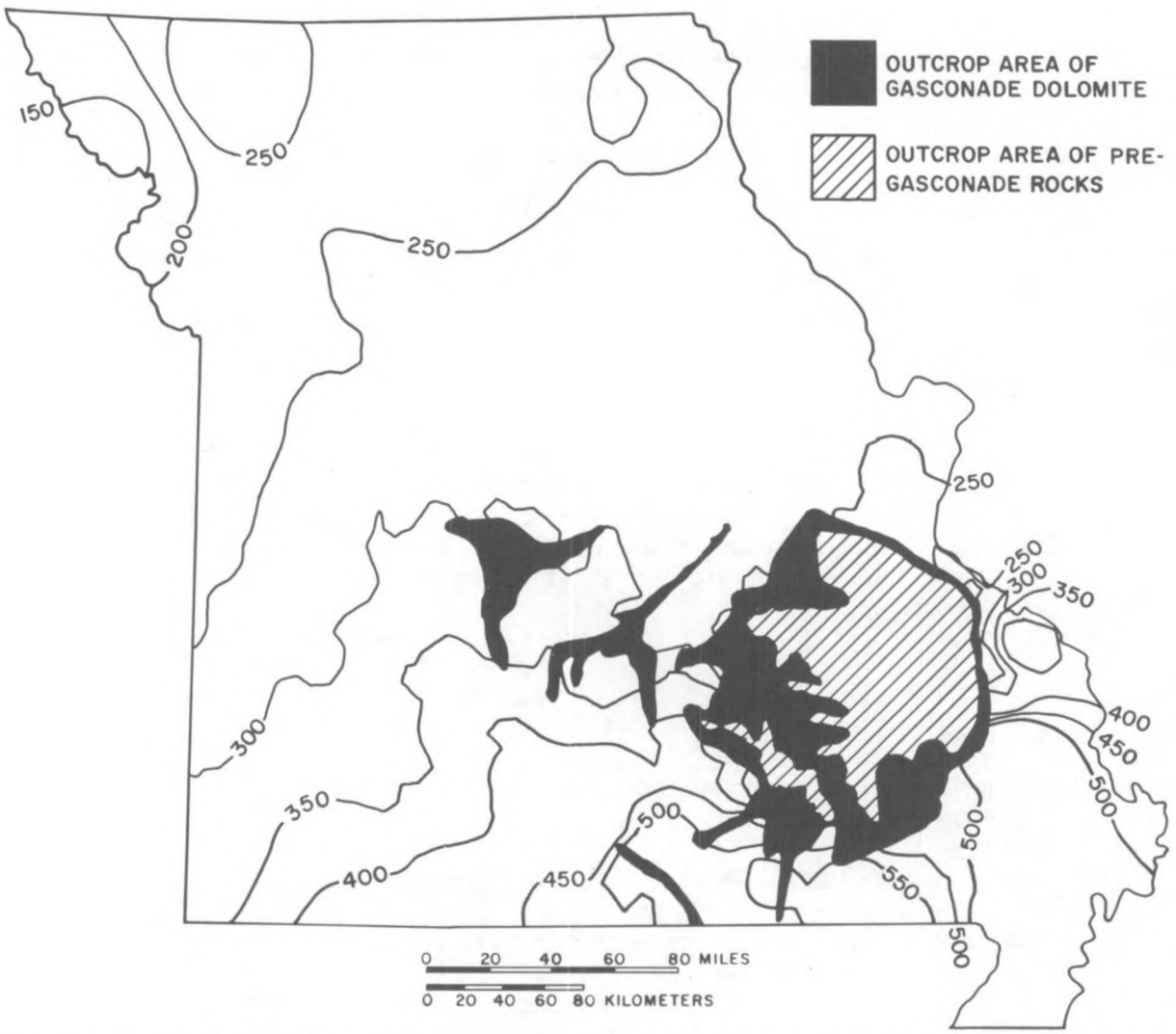


Figure 12. *Isopach map, distribution, and areas of outcrop of the* **Gasconade Dolomite** *in Missouri. Isopach interval is 50 ft.*

Gasconade" is marked by a heavy chert zone comprising silicified algae and/or stromatolites (fig. 11). Where the lower Gasconade is chert-free, it has been called the **Van Buren formation** in Missouri literature. Although the "Van Buren" was first distinguished as part of the upper Eminence Dolomite by Ulrich (unpublished), the name was first published by McQueen (1929), as the lower part of the unit now called Gasconade, the base of which was the Gunter Sandstone Member. Thus, early usage defined a three-part Gasconade: the basal chert-free Van Buren, a very cherty middle Gasconade, and the low-chert upper Gasconade. Later a two-part division was used. Derived from exposures near Van Buren, Carter County, south-central Missouri, the name "Van Buren" has been abandoned in favor of "Gasconade."

The **"upper Gasconade"** is usually a nearly chert-free, massive, finely to medium-crystalline dolomite, with only occasional chert or sandstone stringers in the upper part. The "upper Gasconade" is identified as **Richland** in some residue logs on file at the Missouri Department of Natural Resources, Division of Geology and Land Survey. Weathering of the "upper Gasconade" produces massive ledges, with "pock-marks" about 0.5 to 1 in. in diameter.

The Gasconade Dolomite was described as follows by Martin et al. (1961a, p. 22):

> "Several varieties of chert characterize different parts of the Gasconade. The chert in the lower part, above the Gunter, is often oolitic with some of the ooliths being free and bean-shaped. The chert in the middle part

includes a smooth, white, porcelaneous type and another type that has a 'dead' appearance. The lower half of the upper 25 to 30 feet of the formation contains small amounts of brown- and gray-banded chert."

Monoplacophorans are relatively abundant in localized pockets associated with stromatolitic zones (Stinchcomb, 1986). In much of the Gasconade, however, fossils are rare, although gastropods, brachiopods, and trilobites are known to occur; gastropods, for example, are mostly recovered from the chert. Widespread cryptozoon masses (algal or stromatolitic organisms) are present in the formation. The most persistent masses are 30 to 50 ft below the top of the formation and mark the top of the "lower Gasconade."

Gasconade strata form many of the nearly vertical bluffs and cliffs along central Ozark streams. Caves and springs are common in the formation. The Gasconade Dolomite crops out in a large region around the St. Francois Mountains, in the region of Lake of the Ozarks, and in major river valleys between them (fig. 12). It is present beneath younger strata throughout most of the state. In the central Ozarks, the average thickness of the Gasconade is 300 ft. Data from wells in southeastern Missouri indicate the Gasconade is at least 700 ft thick in that region.

During projects requiring detailed geologic mapping, it is difficult to identify with certainty Gasconade-Roubidoux strata in extreme southern and southeastern Missouri. Facies changes in characteristic or key horizons, such as sandstone beds, chert beds, etc., make it difficult or impossible to identify some of them. The entire sequence is primarily dolomite, with much less clastics and chert than the central Missouri type area. Fractured Gasconade dolomite, and sandstones of the overlying Roubidoux Formation, are important aquifers in central Missouri.

Gunter Sandstone Member of Gasconade Dolomite

Ball and Smith, 1903

Original description -- (Ball and Smith, 1903, p. 28) "The Gunter sandstone varies in texture from fine- to coarse-grained. The usually well rounded character of the individuals [grains] is evidence that they have been well worked over by the sea and carried long distances before being deposited..."

"In places this formation is quite calcareous, the small quartz grains being imbedded in a matrix of calcite and secondary silica...The usual cementing material is silica, but in places...calcite predominates."

(p. 27) "Cross bedding is common in the Gunter sandstone, there being few exposures in which it does not show."

Type section -- The Gunter Sandstone was named from Gunter Spring (Hahatonka Spring, Ha Ha Tonka State Park), E½W½ sec. 2, T. 37 N., R. 17 W., Hahatonka 7½' Quadrangle, Camden County, Missouri. The name was derived from the abandoned Gunter post office in Miller County, and from Gunter Spring, now known as Hahatonka Spring (figs. 13-15).

Reference section -- An excellent exposure illustrating the relationship of the Gunter Sandstone Member to the underlying Eminence Dolomite is in a roadcut on the south side of U.S. Highway 60 (fig. 16), in SW¼ NW¼ sec. 18, T. 27 N., R. 1 E., Garwood 7½' Quadrangle, Carter County, Missouri. This section was described by Muilenberg and Beveridge (1954, p. 35).

History of nomenclature

1855	Swallow	3rd Sandstone
1892	Nason	Roubidoux sandstone (part; locally)
1894	Winslow	Cole Camp sandstone
1898	Keyes	3rd sandstone
1900	Gallaher	Roubidoux sandstone
1902	Weeks	Moreau sandstone (Keyes, 1894)
1903	**Ball and Smith**	**Gunter sandstone**

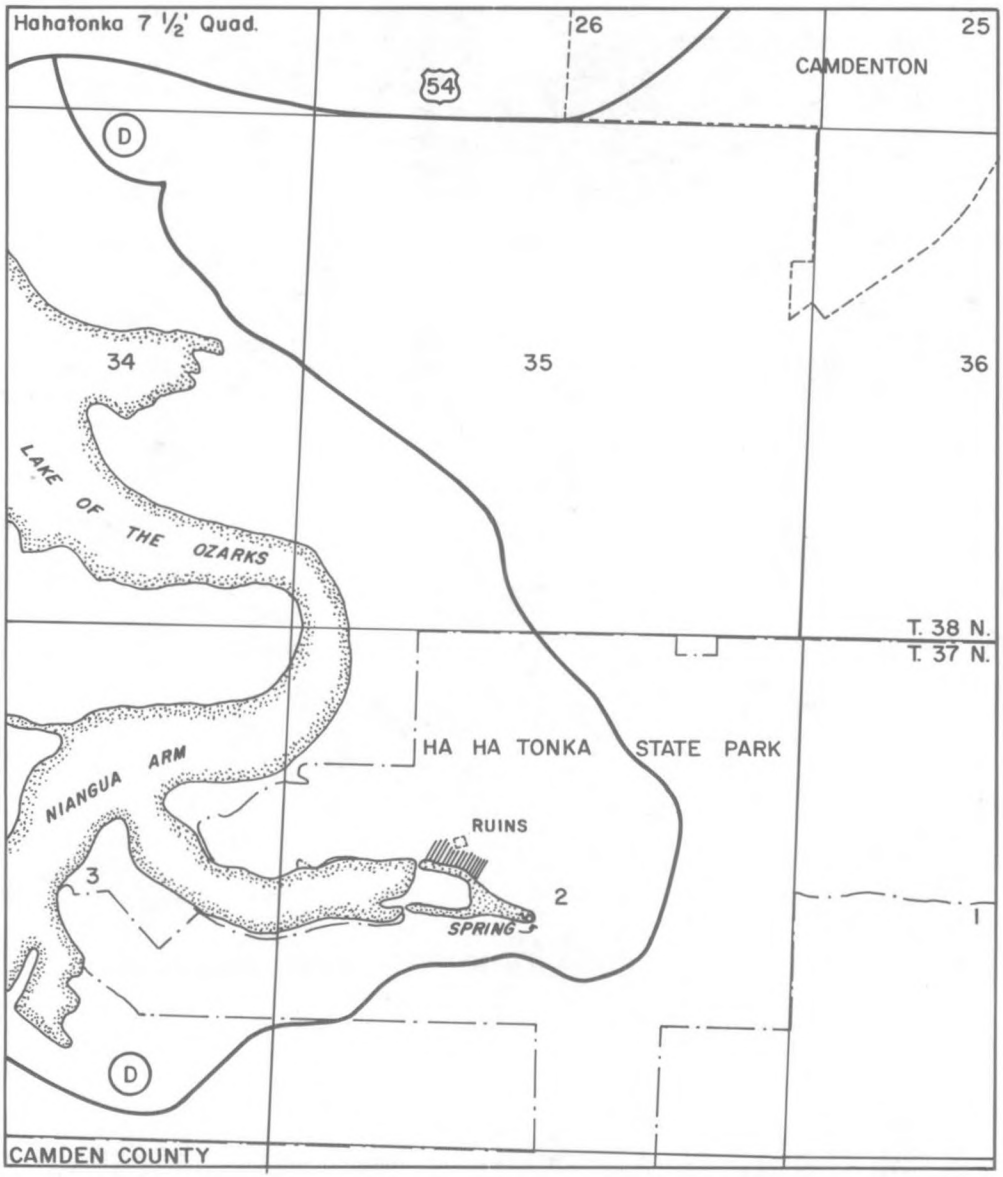
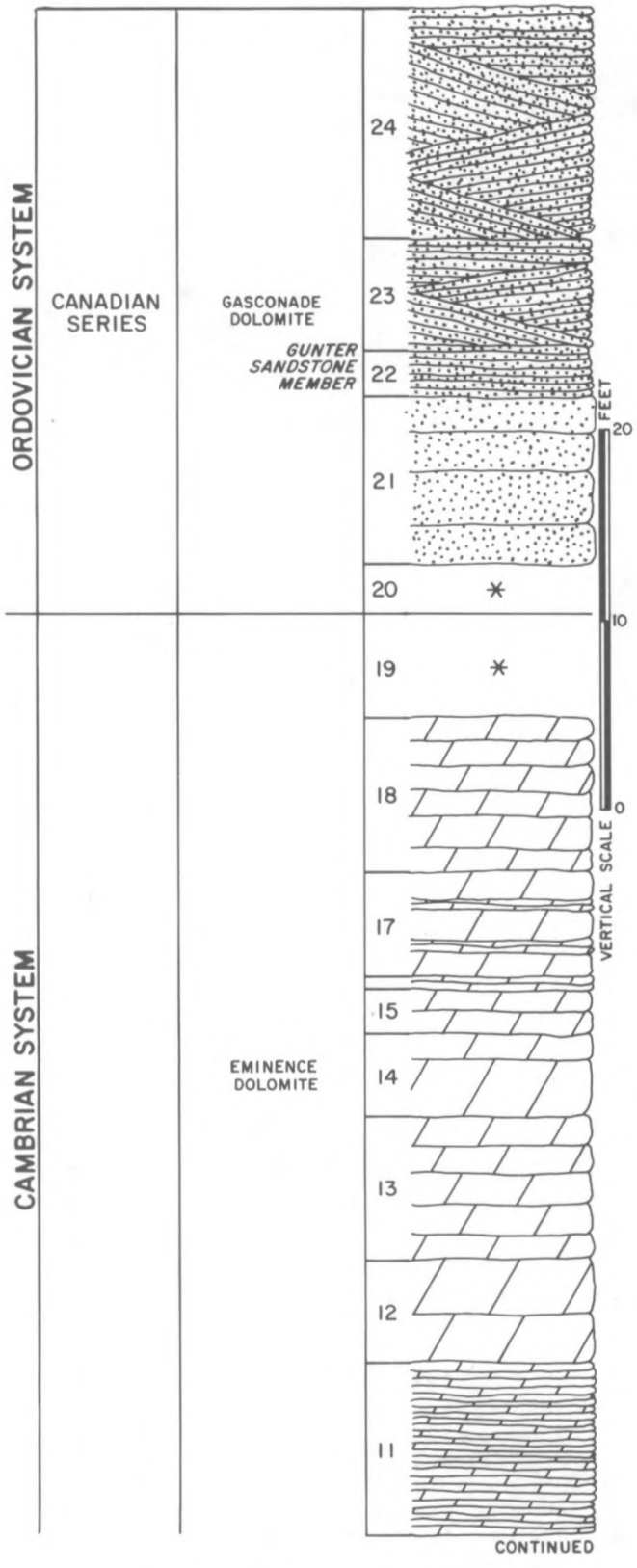


Figure 13. *Part of the Hahatonka 7½' Quadrangle showing location of type section of the* **Gunter Sandstone Member of the Gasconade Dolomite,** *Hahatonka Spring, center E½ W½ sec. 2, T. 37 N., R. 17 W., Camden County, Missouri.*

1905	Bain and Ulrich (a, b)	Gunter sandstone (Cole Camp sandstone)
1907	Marbut	Gunter sandstone member of Gasconade formation
1929	McQueen	Gunter sandstone member of Van Buren formation
1961	Martin et al. (a)	Gunter member of Gasconade formation
1982	Thompson	Gunter Sandstone Member of Gasconade Dolomite
1991	**Thompson (present report)**	**Gunter Sandstone Member of Gasconade Dolomite**

Remarks -- The Gunter Sandstone Member, which is the basal unit of the Gasconade Dolomite, is well developed as a medium-grained quartzose sandstone, 25 to 30 ft thick, from the Lake of the Ozarks region, in central Missouri, southward to Taney County, in southwestern Missouri (fig. 17). East and west of this region of well-developed sandstone, the Gunter is represented by a sandy dolomite that in many places is just a few feet thick. A basal conglomerate containing pebbles from the underlying Eminence Dolomite



ORDOVICIAN SYSTEM - CANADIAN SERIES

Gasconade Dolomite

Gunter Sandstone Member (34 ft 7 in.)

24. Sandstone, white, cross-bedded, friable, thin-bedded. (12 ft 7 in.)
23. Sandstone, white, cross-bedded, saccharoidal, thin-bedded; a few scattered shale seams. (7 ft 5 in.)
22. Sandstone, white, friable, thin-bedded. (2 ft 7 in.)
21. Sandstone, white to buff, firmly cemented; weathers black, mottled with white; a few scattered, thin shale seams. (9 ft 3 in.)
20. Covered interval. (2 ft 9 in.)

CAMBRIAN SYSTEM

Eminence Dolomite (121 ft)

19. Covered interval. (6 ft)
18. Dolomite, buff- and gray-mottled, coarsely crystalline, hard; weathers to coarsely pitted cavernous surface; breccia-filled cavities. (8 ft 2 in.)
17. Dolomite, buff, crystalline to granular; weathers dark-gray to buff; thick and thin beds; smooth on weathered surface. (6 ft 6 in.)
16. Dolomite, pink to buff; weathers buff to gray; thin, hackly beds. (11 in.)
15. Dolomite, light-pink to buff, hard, granular; weathers light-gray. (2 ft 4 in.)
14. Dolomite, gray, medium- to thick-bedded; weathers light-gray with smooth surface. (5 ft 4 in.)
13. Dolomite, buff to gray, slightly argillaceous; weathers dark-gray; medium- to coarsely pitted surface. (8 ft)
12. Dolomite, gray-buff, hard, granular; weathers massive. (5 ft 10 in.)
11. Dolomite, finely crystalline, very thin-bedded; weathers dirty-gray. (9 ft)

Figure 14. *Type section of the* **Gunter Sandstone Member of the Gasconade Dolomite,** *a bluff overlooking Hahatonka Spring, center E½ W½ sec. 2, T. 37 N., R. 17 W., Camden County, Missouri (fig. 13), Adapted from Hendricks (1942, unpublished M.S. thesis, State University of Iowa).*

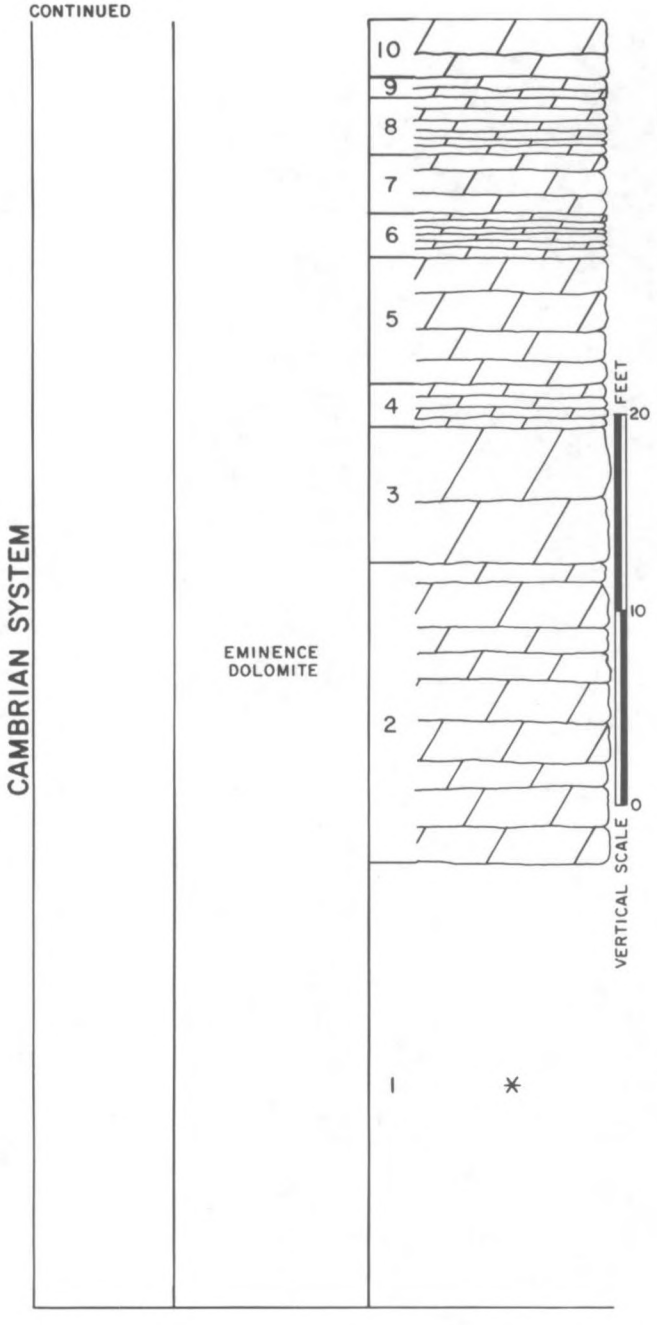


Figure 14 (cont.)

10. Dolomite, buff to gray, hard, finely crystalline, massive; weathers to minutely pitted surface. (3 ft)
9. Dolomite, buff, soft, argillaceous. (1 ft 2 in.)
8. Dolomite, light-gray, hard, finely crystalline, thin- to medium-bedded; weathers like no. 10. (2 ft 11 in.)
7. Dolomite, light-gray to buff, granular to crystalline; weathers dirty-gray; pitted surface; evidence of solution on joint planes. (3 ft 7 in.)
6. Dolomite, pink to buff, very thin-bedded; weathers dirty-buff; blocky fracture. (2 ft 7 in.)
5. Dolomite, buff to gray, granular, even bedded; weathers to minutely pitted surface. (6 ft 3 in.)
4. Dolomite, pink to buff, finely crystalline, hard; irregular, thin beds; hackly fracture. (2 ft 2 in.)
3. Dolomite, very massive, harder and more crystalline than no. 2; numerous stylolites; smooth weathered surface. (7 ft)
2. Dolomite, gray to buff, crystalline to granular, glauconitic, irregular thin to massive beds; weathers dirty-gray; hackly fracture; weathers with pitted face. (16 ft 3 in.)
1. Covered interval, to water level. (24 ft)

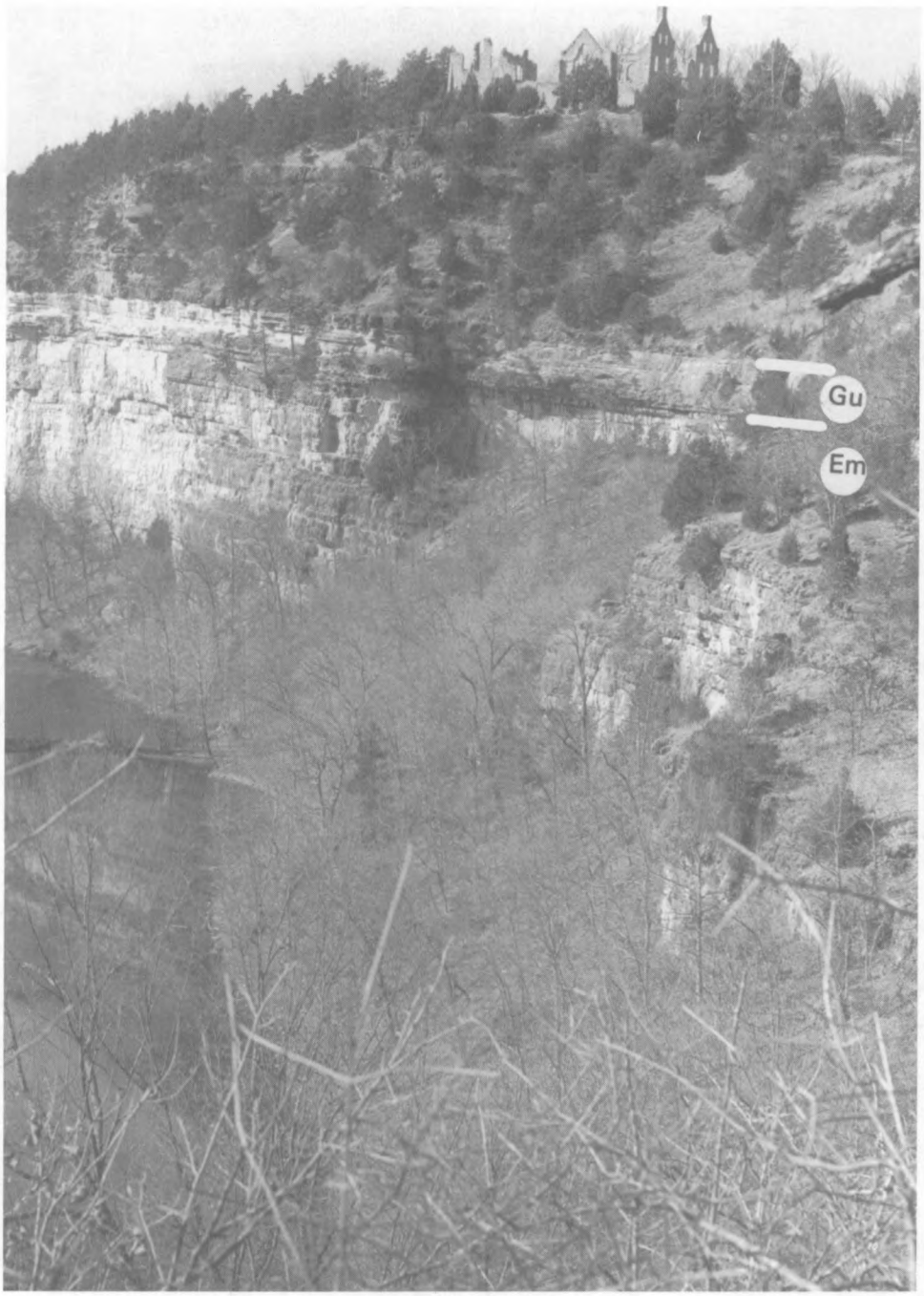
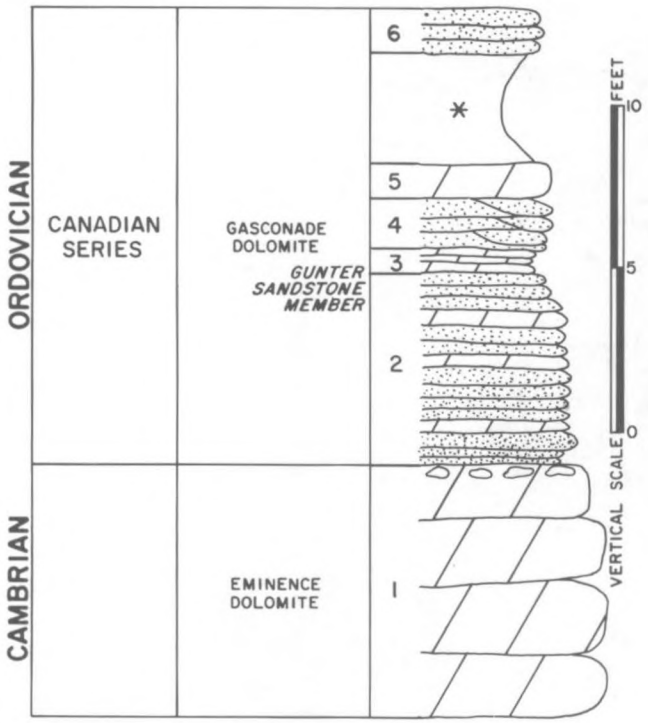


Figure 15. *Type section of the* **Gunter Sandstone Member of the Gasconade Dolomite,** *center E½ W½ sec. 2, T. 37 N., R. 17 W., Camden County, Missouri (figs. 13 and 14).* **(Em)** *Eminence Dolomite;* **(Gu)** *Gunter Sandstone Member of the Gasconade Dolomite. Photograph by James E.Vandike.*



ORDOVICIAN SYSTEM - CANADIAN SERIES

Gasconade Dolomite

Gunter Sandstone Member

6. Sandstone, white to reddish-brown, friable, medium- to coarse-grained, rounded and frosted. Overlain by sandstone float. (1 ft 4 in.)

Covered interval. (3 ft 6 in.)

5. Dolomite, gray to pinkish-gray, finely crystalline; single bed; weathers to thin beds. (1 ft 1 in.)
4. Sandstone, white to reddish-brown, cross-bedded. (1 ft 8 in.)
3. Dolomite, light-gray, finely crystalline; thin, wavy beds weather to rubble. (0 ft 9 in.)
2. Sandstone, reddish-brown to white, medium- to coarse-grained; in beds 1 in. to 7 in. thick; contains lenses of finely crystalline, slightly sandy dolomite. (5 ft 9 in.)

CAMBRIAN SYSTEM

Eminence Dolomite

1. Dolomite, gray, coarsely crystalline, medium- to thick-bedded; upper 10 in. to 24 in. contains honeycombed chert with gastropods. (8 ft).

Figure 16. *Upper Cambrian Eminence Dolomite and basal Ordovician* **Gunter Sandstone Member of the Gasconade Dolomite** *exposed in a roadcut on the south side of U.S. Highway 60, SW¼ NW¼ sec. 18, T. 27 N., R. 1 E., Garwood 7½' Quadrangle, Carter County, Missouri. Adapted from a description by Muilenberg and Beveridge (1954, p. 35).*

has been noted in the Gunter in a few places and provides evidence for a possible disconformity between the Gasconade and the Eminence. In earlier reports the lower chert-free Gasconade was called **Van Buren**, and the Gunter Sandstone, a member of the Van Buren.

Martin et al. (1961a, p. 22) stated,

> "The Gunter sandstone is one of the most reliable field mapping units in the lower Paleozoic of the Ozark region. It is also a reliable subsurface marker throughout most of the state...A number of deep municipal water wells in the state produce from the Gunter."

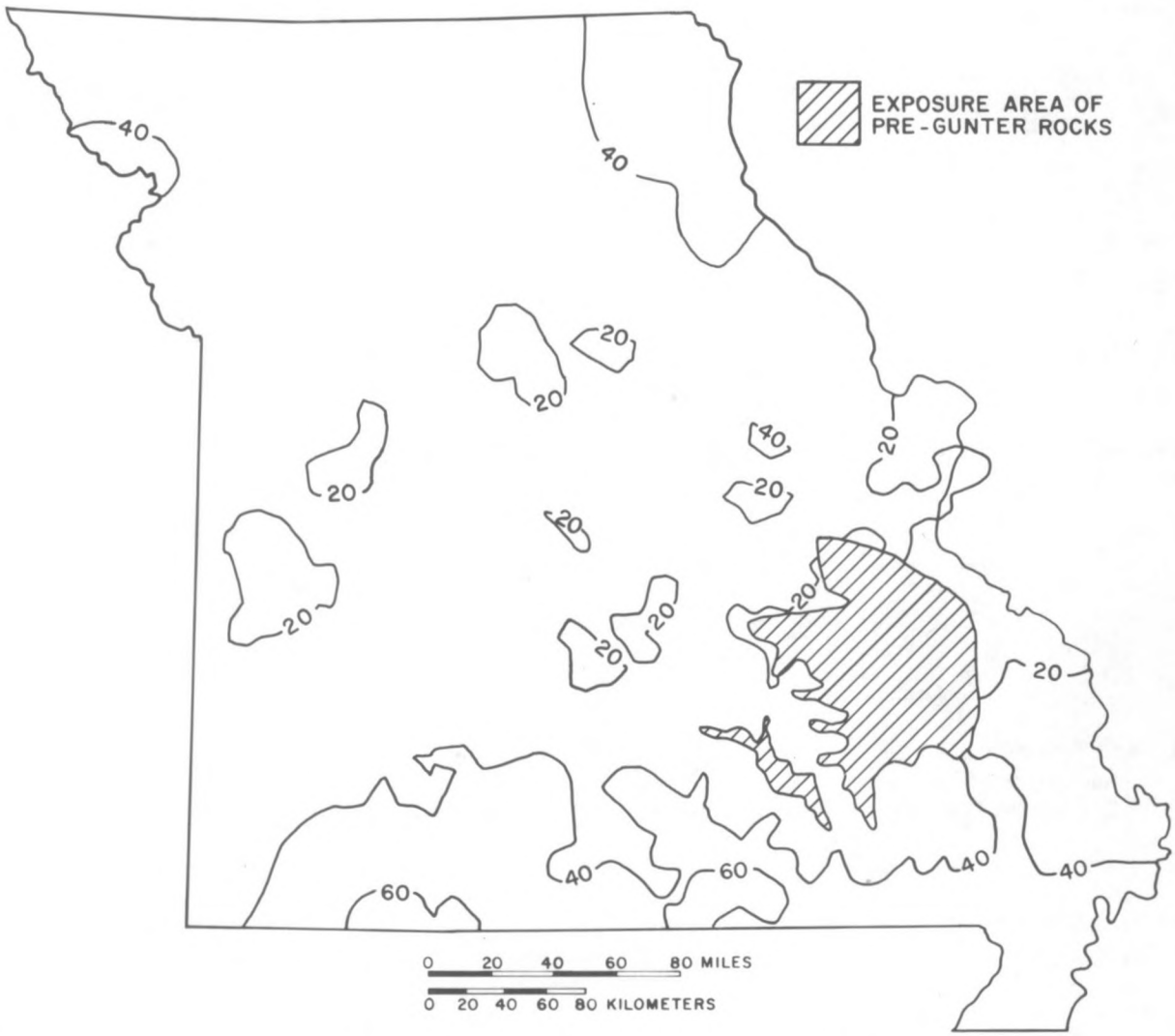


Figure 17. *Isopach map and distribution of the* **Gunter Sandstone Member of the Gasconade Dolomite** *in Missouri. Isopach interval is 20 ft.*

Roubidoux Formation

Nason, 1892

Original description -- (Nason, 1892, p. 114-115) "...it is suggested that the name *Roubidoux* sandstone be applied to the rock above described as overspreading the Ozark region from Cabool to Gasconade City and from Salem to Doniphan. This embraces much, if not all, of what has been called Second sandstone, and will undoubtedly include the areas of so-called First sandstone as well...It is firmly believed that enough occurrences have been examined to at least include all of the great outcrops of sandstone properly lying within the Ozark Uplift in the Roubidoux sandstone, and, if further work proves the correctness of the writer's belief that the heavy beds of sandstone at Pacific and Crystal City, hitherto known as First sandstone, are but an extension of the Second sandstone, the term Roubidoux can be extended to these also."

Type section -- Heller (1954, p. 17) stated, "As originally defined, the Roubidoux formation was without a specifically designated type section. By inference the area of exposure along Roubidoux Creek in Pulaski and Texas counties came to be known as the 'type area' and has since often been cited as such. During the course of this investigation exposures in this area were studied and measured at several localities, but only one complete section, the Roubidoux Creek Section, was located.

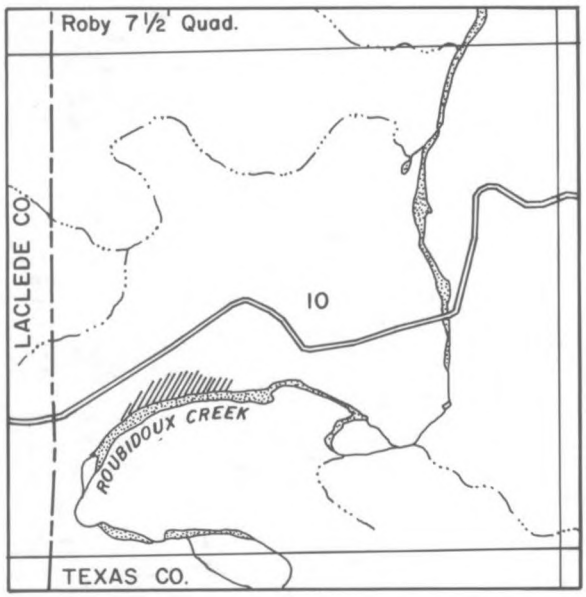


Figure 18. *Part of the Roby 7½' Quadrangle showing the location of the type section of the* **Roubidoux Formation**, *SE¼ NW¼ SW¼ sec. 10, T. 33 N., R. 12 W., Texas County, central Missouri.*

"The Roubidoux Creek Section, which is here designated the type area section for the Roubidoux formation is exposed along a southeast-facing hillside above Roubidoux Creek in the SE¼ NW¼ SW¼ sec. 10, T. 33 N., R. 12 W., Texas County [Roby 7½' Quadrangle], Missouri."

This exposure, on the bluff just south of the abandoned Cedar Bluff school (fig. 18), can be reached from a (p. 57) "...secondary road which leads from Missouri State Highway 17 to the Gulf Oil Pumping Station, the section is easily located and readily accessible." Approximately 150 ft of Roubidoux is exposed at this section (fig. 19).

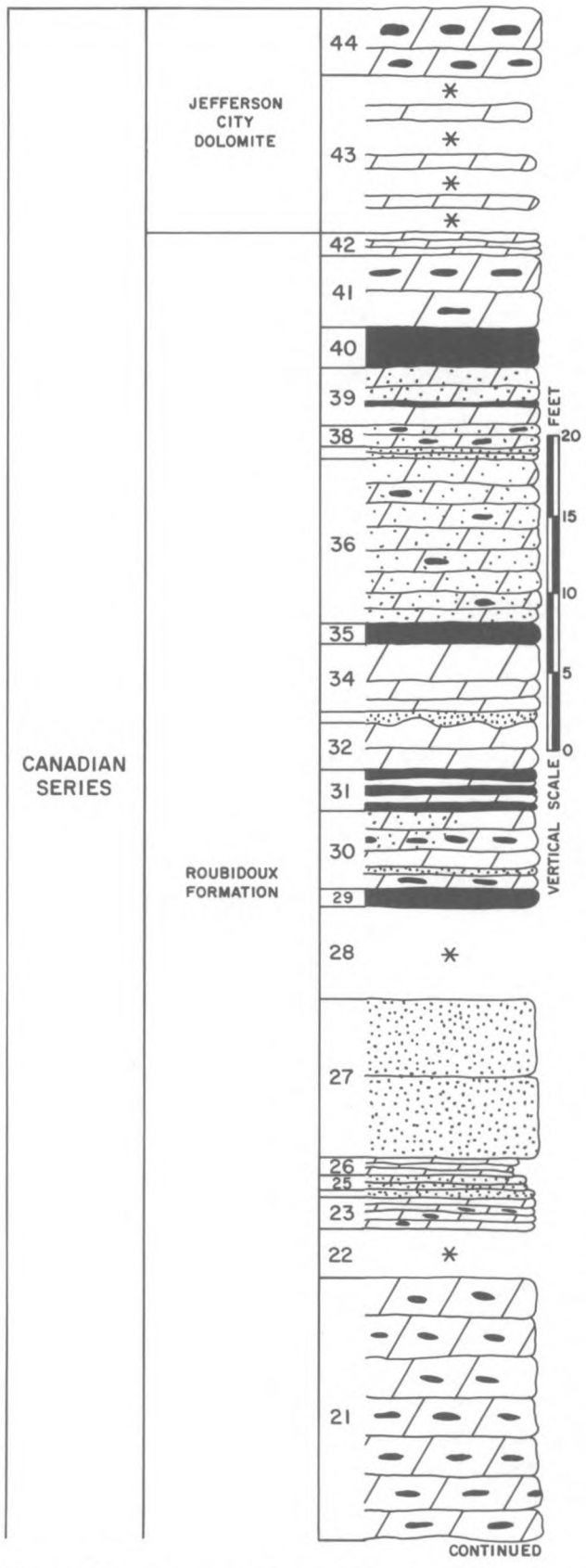
Reference sections -- Over 100 ft of lower Roubidoux is exposed on the east side of Missouri Highway 17, at the bridge over Jacks Fork, center S½ NW¼ sec. 36, T. 28 N., R. 7 W., Pine Crest 7½' Quadrangle, southeastern Texas County, south-central Missouri. At this section (fig. 20), described by Muilenberg and Beveridge (1954, p. 38), dolomite and sandy dolomite are the dominant lithologies in the Roubidoux Formation, although several sandstone beds occur in the section.

Another accessible section of upper Gasconade, Roubidoux, and lower Jefferson City is located along I-44 between the Saint Robert exit and bridge over Roubidoux Creek (fig. 9), from NW¼ SW¼ to the NE¼ NE¼ sec. 30, T. 36 N., R. 11 W., Waynesville 7½' Quadrangle. This section was described by Beveridge and Aughenbaugh (1972).

An easily accessible exposure of the Gasconade-Roubidoux contact is a small roadcut at the west end of the north frontage road to I-44 about 2 mi west of the west Rolla interchange (fig. 21), Phelps County, Missouri, SE¼ SW¼ sec. 8, T. 37 N., R. 8 W., Rolla 7½' Quadrangle.

History of nomenclature

1855	Swallow	2nd Sandstone
1874	Broadhead	2nd sandstone
1892	**Nason**	**Roubidoux sandstone** (part; included Gunter and St. Peter sandstones in places)
1894	Winslow	Moreau sandstone (central Missouri) St. Peter sandstone (on correlation table) Crystal City sandstone (part; southeastern Missouri)
(not) 1894	Winslow	Roubidoux sandstone (= St. Peter Sandstone)
1898	Keyes	2nd sandstone
1900	Gallaher	Moreau sandstone (part) St. Thomas sandstone
(not) 1900	Gallaher	Roubidoux sandstone (= Gunter Sandstone Member of Gasconade Dolomite)



ORDOVICIAN SYSTEM - CANADIAN SERIES

Jefferson City Dolomite

44. Dolomite, light-brownish-gray, fine-grained, vuggy, massively bedded; contains abundant large rounded nodules of light- to medium-gray, banded, porcelaneous, non-sandy chert. (3 ft 8 in.)
43. Covered interval; numerous poor exposures of very fine-grained, argillaceous, tan dolomite ("cotton rock"). (9 ft 8 in.)

Roubidoux Formation

42. Dolomite, light-brownish-gray, fine-grained, very sandy; and sandstone, light-brownish-gray, fine-grained, dolomitic; thin-bedded; contains small amount of light-gray, sandy, oolitic chert. (1 ft)
41. Dolomite, light-brownish-gray, fine-grained, vuggy, massively bedded; contains moderate amount of irregular nodules of light- to medium-gray, porcelaneous to sandy chert. (5 ft.)
40. Chert, light- to medium-gray, quartzose to sandy and oolitic, massively bedded. (2 ft 6 in.)
39. Dolomite, light-brownish-gray to cream, fine- to very-fine-grained, pure to sandy, medium-bedded; occasional thin beds of light-gray to medium-brownish-gray, often sand-centered, oolitic chert. (3 ft 4 in.)
38. Dolomite, light-brownish-gray, fine-grained, slightly sandy; abundant light- to dark-gray irregular nodules and masses of quartzose to drusy and sandy, partly algal, oolitic chert. (1 ft)
37. Sandstone, light-gray, fine-grained, quartzitic, thin-bedded. (4-8 in.)
36. Dolomite, light-brownish-gray, fine-grained, sandy, medium-bedded; occasional irregular nodules and angular fragments of light- to dark-gray, oolitic chert. (10 ft 8 in.)
35. Chert, light-gray to medium-dark-gray, oolitic and sandy to sub-chalcedonic (some oolites have sand-centers). (1 ft 0-6 in.)
34 Dolomite, light-gray, fine- to coarse-grained, vuggy, massively bedded. (3 ft 10 in.)
33. Sandstone, light-gray, fine-grained, quartzitic; conglomerate near top; some medium-gray porcelaneous chert. (6-10 in.)
32. Dolomite, light-brownish-gray, fine- to medium-grained, vuggy, massively bedded. (2 ft 6 in - 3 ft.)
31. Chert, light-gray to medium-brownish-gray, banded; porcelaneous to quartzose to sandy and oolitic; bedding irregular; some interbedded light-brownish-gray, fine- to medium-grained dolomite. (2 ft 6 in.)
30. Dolomite, light-brownish-gray, very fine-grained, locally sandy, medium-bedded; occasional thin beds and nodules of light- to medium-gray, porcelaneous to sandy chert; thin lenses of fine-grained sandstone. (5 ft)
29. Chert, light- to medium-gray, sandy, oolitic, medium-bedded. (1 ft 2 in.)
28. Covered interval. (5 ft 8 in.)
27. Sandstone, light-gray, fine-grained, massively bedded; a few thin quartzitic sandstone lenses. (8-12 ft)
26. Dolomite, light-gray to steel-gray, fine- to medium-grained, thin-bedded (0.25-1 in.); forms reentrant under massive sandstone. (1 ft 2 in.)
25. Dolomite, light-brownish-gray to medium-gray, fine-grained, very sandy, thin-bedded. (8 in.)
24. Sandstone, light-gray, fine-grained, medium-bedded. (8 in.)
23. Dolomite, light-brownish-gray to steel-gray, fine-grained, thin-bedded; some white porcelaneous chert. (2 ft)
22. Covered interval. (2 ft 9 in.)
21. Dolomite, light-brownish-gray, medium-grained, massive beds; abundant irregular masses of light- to medium-gray porcelaneous chert. (16 ft 1 in.)

Figure 19. *Type section of the* **Roubidoux Formation,** *SE¼ NW¼ SW¼ sec. 10, T. 33 N., R. 12 W., Texas County, central Missouri (fig. 18). Adapted from a description by Heller (1954, p. 57-60).*

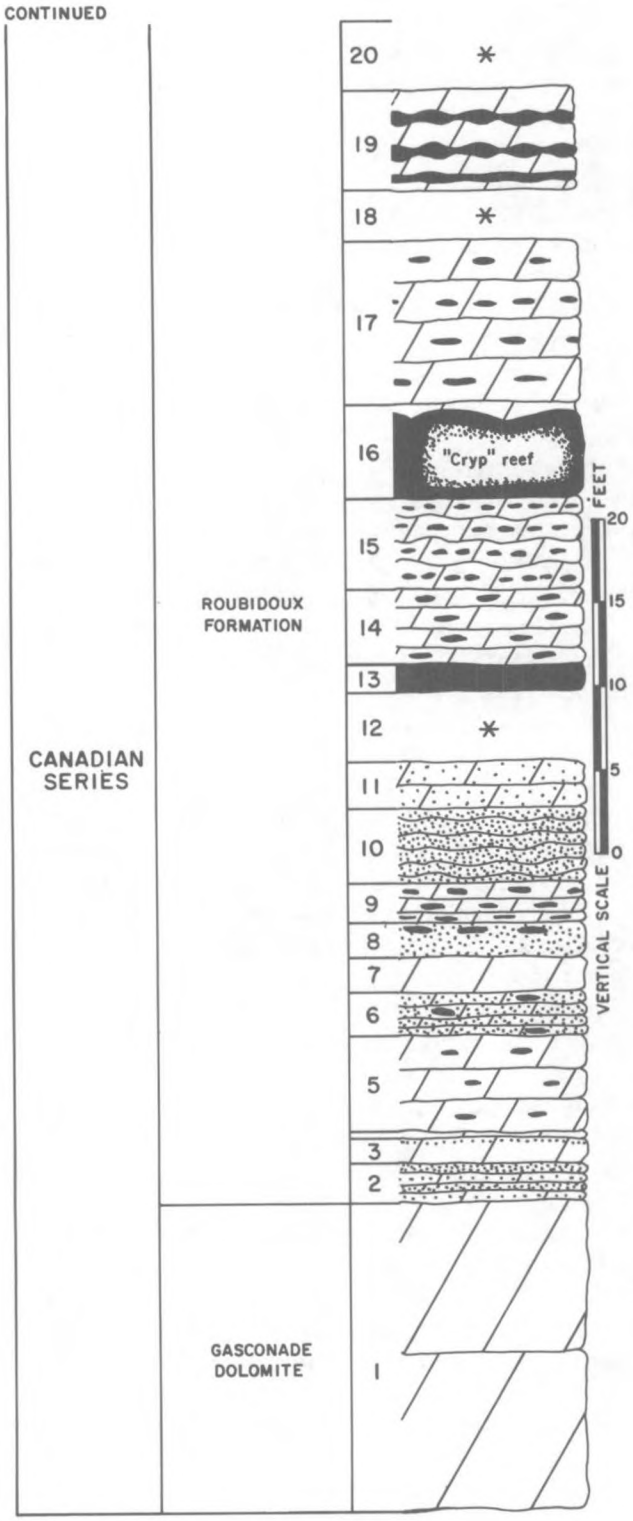


Figure 19 (cont.)

20. Covered interval. (4 ft 4 in.)
19. Dolomite, light-brown to tan, fine- to medium-grained, slightly sandy, irregularly bedded; light- to medium-gray porcelaneous to sandy and oolitic chert. (5 ft 8 in.)
18. Covered interval. (2 ft 8 in.)
17. Dolomite, light-brownish-gray, fine- to medium-grained, vuggy, massively bedded; abundant small nodules of light-gray to medium-dark-brown porcelaneous sandy chert. (9 ft 8 in.)
16. Chert, light- to medium-dark-gray, porcelaneous to subchalcedonic, irregularly banded; some poorly developed algal structures; some inclusions of light-brown fine-grained dolomite. (5 ft 8 in.)
15. Dolomite, light-gray to tan, medium-grained, irregularly bedded; irregular lenses, stringers, and angular fragments of white to light-gray porcelaneous chert scattered throughout the dolomite. (5 ft)
14. Dolomite, light-brownish-gray, fine-grained, vuggy, medium-bedded; abundant small, botryoidal masses of light-gray subchalcedonic chert and large nodules of dead-white porcelaneous chert. (4 ft 9 in.)
13. Chert matrix sand, light-gray, fine-grained; matrix light gray porcelaneous chert; thin to medium-bedded. (1 ft 4 in.)
12. Covered interval. (3 ft 10 in.)
11. Dolomite, light-brownish-gray, fine-grained, sandy to very sandy, massively bedded; weathers to dirty gray. (2 ft 9 in.)
10. Sandstone, light-gray, fine-grained, locally quartzitic irregular beds. (4 ft 10 in.)
9. Dolomite, light-brownish-gray, fine-grained, medium bedded; abundant smooth white-weathering chert. (2 ft 4 in.)
8. Sandstone, light-brown, fine-grained, massively bedded; occasional lenses of very sandy oolitic medium-gray chert breccia in top of unit. (2 ft 1 in.)
7. Dolomite, light-brownish-gray, fine- to medium-grained, vuggy; weathers to pitted surface. (2 ft 1 in.)
6. Sandstone, light-brownish-gray, fine-grained, dolomitic, locally quartzitic, thin-bedded; grades locally into sandy dolomite; abundant thin lenses and nodules of light- to medium-gray porcelaneous to sandy chert. (2 ft 6 in.)
5. Dolomite, light-brown, fine- to medium-grained, slightly vuggy, medium to massively bedded; small nodules of light- to dark-gray porcelaneous chert. (6 ft)
4. Dolomite, light-brownish-gray, fine-grained, argillaceous, thin-bedded. (3 in.)
3. Dolomite, light-brownish-gray, fine- to medium-grained, massively bedded; thin bed of dolomitic sandstone at top. (2 ft)
2. Sandstone, light-brownish-gray, fine-grained, rounded and frosted, well-cemented, dolomitic; dolomite, light-brownish-gray, fine-grained, very sandy; thin- to medium-bedded. (2 ft 4 in.)

Gasconade Dolomite

1. Dolomite, light-brownish-gray to light-gray, fine- to coarse-grained, massively bedded, non-cherty. (18 ft 4 in.)

1902	Weeks	Roubidoux sandstone
1903	Ball and Smith	St. Elizabeth formation (includes Bolin Creek sandstone member; rejected "Roubidoux")
1904	Buckley and Buehler	Roubidoux
	Shepard	Roubidoux sandstone Marshfield sandstone
	Ball	St. Elizabeth formation
1905	Bain and Ulrich (a, b)	Roubidoux formation (reintroduced)
	Van Horn and Buckley	St. Elizabeth formation
1907	Marbut	Roubidoux formation (includes Bolin Creek sandstone member)
1933	Oder	Knox dolomite (middle part)
1940	Bridge and Girty	Roubidoux sandstone ("= upper Ellenburger limestone of Texas")
1954	**Heller**	**Roubidoux formation**
1961	Martin et al. (a)	Roubidoux formation
1963	Sloss	Roubidoux Sandstone (Sauk sequence)
1964	Harlton	Cool Creek Formation (in Oklahoma; "equivalent to Roubidoux of Ozark Mountains of Missouri")
1982	Thompson	Roubidoux Formation
1986	Stinchcomb	Roubidoux Formation
1991	**Thompson (present report)**	**Roubidoux Formation**

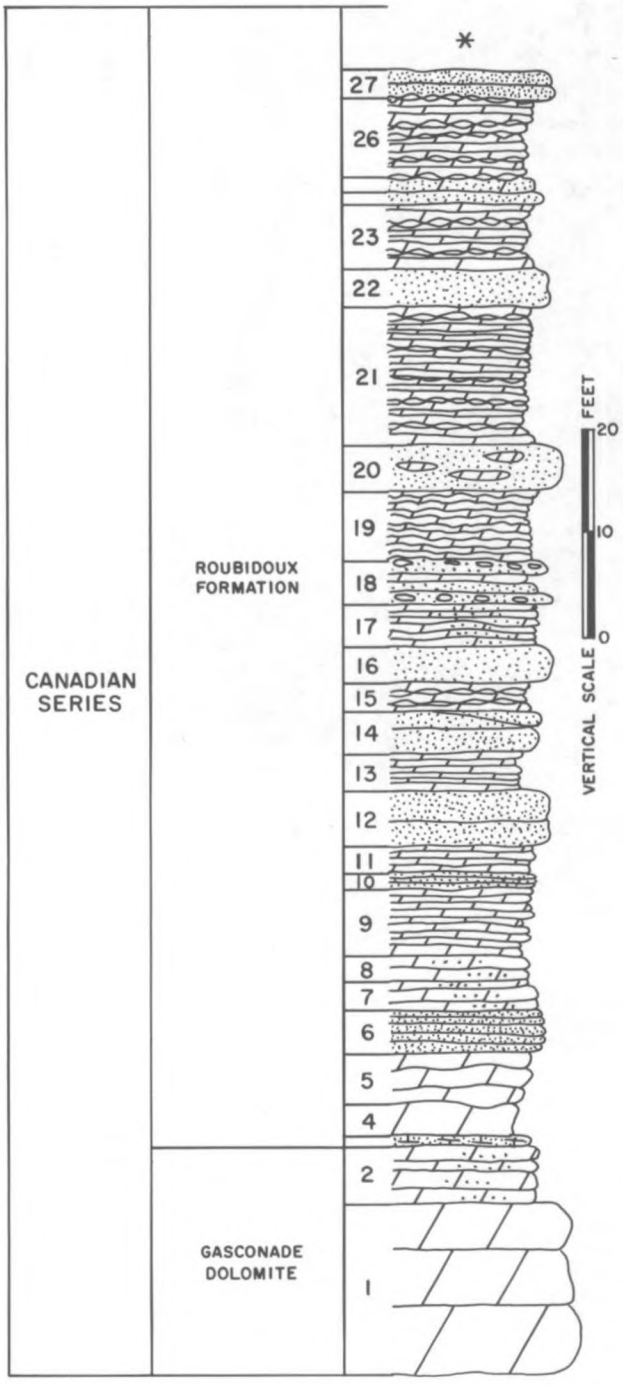
Remarks -- The Roubidoux Formation in Missouri comprises sandstone, sandy dolomite, dolomite, chert, sandy chert, and cherty dolomite. Well-developed sandstone beds are present, but occur at different levels in different regions of the state. In south-central Missouri (around Rolla, Phelps County, for example), a prominent quartzose sandstone occurs near the base of the formation, whereas in southern and southeastern Missouri as little as 10 percent of the formation contains sandstone, most of the rock being dolomite and cherty dolomite that is difficult to distinguish from the underlying lower part of the upper Gasconade Dolomite, a very cherty zone informally called the "red bracket" zone. In western Missouri, the formation contains three distinct sandstone units, one each near the base, middle, and top.

Sandstone in the Roubidoux comprises fine- to medium-grained quartz sand that is characteristically subrounded, frosted, and regenerated. Weathered surfaces are predominantly gray and brown, but fresh surfaces are usually light yellow, tan, or red at the surface and white in the subsurface.

Chert occurs in the Roubidoux as scattered beds and nodules and as thick beds of silicified stromatolitic and algal material that form beds useful in mapping in parts of the outcrop region. Dolomite in the Roubidoux is finely to medium-crystalline, light gray to brown, and thin to thick bedded. The dolomite beds may be chert free, or individual beds may contain brown to gray, banded, oolitic, sandy chert. Some thick chert-free dolomite beds in the upper Roubidoux may be similar to those in the overlying Jefferson City Dolomite.

The Roubidoux crops out in much of southern Missouri and around the Lake of the Ozarks and St. Francois Mountains; it is present in the state throughout the subsurface, downdip from the outcrop region (fig. 22). Although fossils are not abundant in the Roubidoux, some chert locally contains numerous fossils, chiefly mollusks. In many places the sandstone has well-preserved ripple marks, mud cracks, and cross-bedding.

The thicker sandstone units of the Roubidoux Formation are quarried for building stone. The Roubidoux is also an important aquifer in parts of the state; water is recovered from the sandstones and from fractured dolomite. The Roubidoux is 100 to 300 ft thick; it is thickest in the southwestern and southeastern Ozarks and thinnest in northeastern Missouri.



ORDOVICIAN SYSTEM - CANADIAN SERIES

Roubidoux Formation

Covered; overlain by 3 ft 6 in. of sandstone. (22 ft)

27. Sandstone, light-gray to light-yellow and buff, fine-grained, medium-bedded; dolomitic in part. (2 ft 6 in.)
26. Dolomite, light-brownish-gray, fine-grained, thin-bedded, lo cally sandy; contains thin chert lenses. (7 ft)
25. Dolomite, light-brownish-gray to buff, microgranular; contains thin beds of sandstone. (1 ft)
24. Sandstone, fine- to coarse-grained, single bed. (1 ft)
23. Dolomite, light-gray to light-brown, fine-grained; contains small amounts of thin bedded oolitic chert. (6 ft)
22. Sandstone, light- to dirty-gray, fine- to coarse-grained; massive bed; filled desiccation cracks. (3 ft 6 in.)
21. Dolomite, light-brownish-gray to buff, fine- to medium-grained, thin-bedded; numerous thin beds of oolitic, sandy, sparingly fossiliferous chert (*Rhombella* sp.). (12 ft)
20. Sandstone, light-brown to buff, fine- to coarse-grained; massive bed; filled desiccation cracks; small amount of dolomite. (4 ft)
19. Dolomite, light-brownish-gray, fine-grained, thin-bedded, nodular. (6 ft)
18. Sandstone, light-gray to brown, fine- to medium-grained; gray oolitic chert and a few thin beds of dolomite. (3 ft 8 in.)
17. Dolomite, light-brownish-gray to medium-gray, fine-grained, thin-bedded, locally sandy. (4 ft)
16. Sandstone, light-gray to reddish-brown, fine-grained, massive. (3 ft 6 in.)
15. Dolomite, light-gray to light-brownish-gray, fine- to medium-grained; thin lenses of oolitic and ropy chert. (2 ft)
14. Sandstone, light-gray to pink and reddish-brown, fine-grained, cross-bedded to massive. (2 ft 8 in.)
13. Dolomite, dark-brownish-gray to medium-gray, fine-grained. (3 ft)
12. Sandstone, light-gray to reddish-brown, fine-grained, medium-bedded. (4 ft 6 in.)
11. Dolomite, medium-gray to medium-brownish-gray, fine-grained, thin-bedded; vuggy. (2 ft 6 in.)
10. Sandstone, red-brown, fine- to medium-grained, thin-bedded. (1 ft 6 in.)
9. Dolomite, light-gray, fine- to medium-grained, thin-bedded; 1-ft bed of fine-grained argillaceous dolomite near middle. (5 ft 6 in.)
8. Dolomite, beige to tan, fine-grained, medium-bedded, argillaceous, sandy. (2 ft)
7. Dolomite, light-brownish-gray to medium-gray, medium-grained, sandy. (2 ft 6 in.)
6. Sandstone, light-brownish-gray, fine-grained, poorly sorted, thin-bedded, dolomitic; filled desiccation cracks. (4 ft)
5. Dolomite, light-brownish-gray to light-brown, fine-grained, medium-bedded to massive. (7 ft)
4. Dolomite, light-gray to cream, microgranular, thin-bedded to massive, argillaceous and silty; thickens and thins rapidly. (1 ft 4 in.)
3. Sandstone, light-gray to tan, medium-grained, dolomitic; one bed. (11 in.)

Gasconade Dolomite

2. Dolomite, light-brownish-gray, fine-grained, medium-bedded, sandy in part; weathers to smooth surfaces. (5 ft 1 in.)
1. Dolomite, light-brownish-gray to medium-gray, medium- to coarse-grained, massive; vuggy; weathers to pitted surfaces. (52 ft to base of exposure in Jacks Fork)

Figure 20. **Roubidoux Formation** *and upper part of the Gasconade Dolomite exposed on Missouri Highway 17 at the crossing over Jacks Fork, center S½ NW¼ sec. 36, T. 28 N., R. 7 W., southeastern Texas County, Missouri, Pine Crest 7½' Quadrangle. Adapted from a description by Muilenberg and Beveridge (1954, p. 38).*

Figure 21. **Gasconade-Roubidoux contact** *exposed in a roadcut on the north frontage road to I-44 approximately 2 mi west of Rolla, Phelps County, SE¼ SW¼ sec. 8, T. 37 N., R. 8 W., Rolla 7½' Quadrangle.* **(Ga)** *Gasconade Dolomite;* **(Rb)** *Roubidoux Formation. Photograph by T.L. Thompson.*

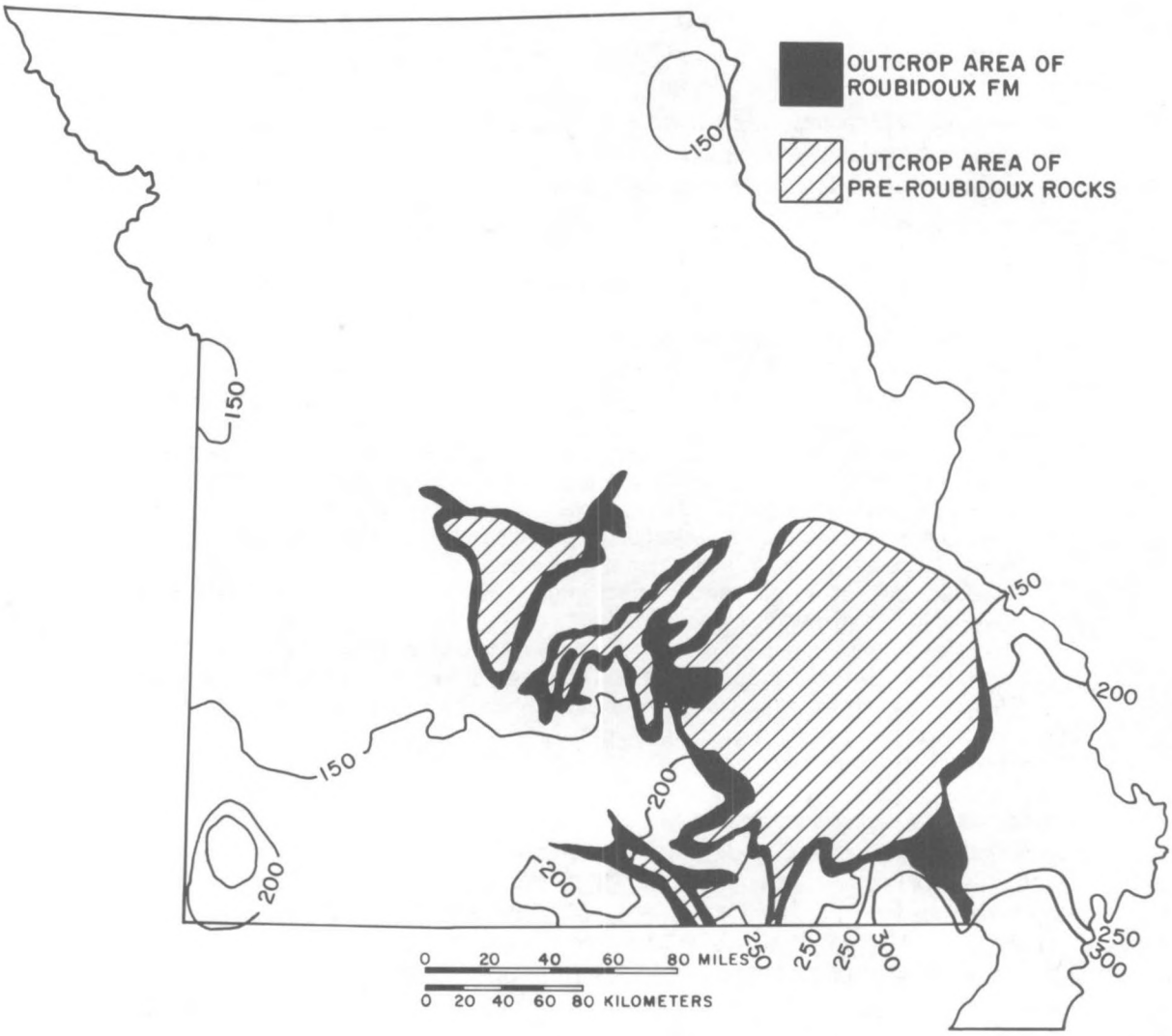


Figure 22. *Isopach map, distribution, and areas of outcrop of the* **Roubidoux Formation** *in Missouri. Isopach interval is 50 ft.*

Jefferson City Dolomite

Winslow, 1894

Original description -- (Winslow, 1894, p. 373) "From the mouth of the Moreau to Grays creek, above Jefferson City, a series of sections were measured, beginning with one at the mouth of the Moreau, illustrated in figure 62. They show in great detail the composition of what we have named the Jefferson City limestone."

"Section at Station 112

Ft	
20	Cotton rock (magnesian limestone) pale blue, weathering to a brown color, layers 8 in. to 2 ft; no chert.
12	Magnesian limestone, massive beds, 2 to 5 ft. thick; granular and hard, some oolitic chert in nodules and lenticular layers, bluish gray, thinly bedded near base.
4	Magnesian limestone, less granular; much glassy nodular chert, some of which is angular and brecciated.
8	Magnesian limestone, massive, siliceous, granular, with a somewhat pitted weathering.
9	Magnesian limestone, more earthy and shaly, in part a cotton rock; fractured in checks; lower 2 ft. cherty in nodules and thin layers.
5	Sandstone (Moreau), or very siliceous magnesian limestone; upper half with layers of quartzite parallel to stratification; also streaks of pure magnesian limestone; false bedded near bottom, and lower contact irregular; weathered surface highly siliceous; interior more like magnesian limestone.
10	Magnesian limestone, massive, granular, upper 2 ft. contain much chert in nodular and thin layers; lower part irregularly bedded in places; elsewhere grading into rock below.
10	Magnesian limestone, massive, gray, pitted on fresh fracture; minute white patches, from decomposed chert; good building rock.
6	Limestone, rugged, with open cavities."

Type section -- No specific section has been designated the type for the Jefferson City Dolomite. Winslow's original descriptions (p. 373-376) were of sections along the south bluffs of the Missouri River Valley, beginning east of the town of Jefferson City at the mouth of the Moreau River, northwest corner of sec. 24, or southwest corner of sec. 13, T. 44 N., R. 11 W., Osage City 7½' Quadrangle, and extending west-northwest to the mouth of Grays Creek, west of Jefferson City, center sec. 35, T. 45 N., R. 12 W., Jefferson City 7½' Quadrangle, Cole County, Missouri (in 1894 possibly located at SW¼ SE¼ sec. 27, T. 45 N., R. 12 W.). The type section could therefore be considered a composite of these exposures between the mouths of the Moreau River and Grays Creek.

Reference sections -- New construction of U.S. Highway 50, in T. 44 N., R. 11 E., Cole County, central Missouri, has produced several new exposures of Jefferson City Dolomite that can be studied for characteristics of that formation. A new roadcut on U.S. Highway 63 immediately south of Westphalia, SW¼ NE¼ sec. 35 and SW¼ sec. 36, T. 43 N., R. 10 W., Osage County, Westphalia East 7½' Quadrangle, contains nearly a complete exposure of the Jefferson City. North of Jefferson City, massive exposures on the north bluff of the Missouri River Valley, in Callaway County, consist mostly of the overlying Cotter Dolomite.

The upper part of a reference section for the Roubidoux Formation, a roadcut on I-44 (figs. 9 and 23B) illustrates the lower part of the Jefferson City Dolomite.

History of nomenclature

1855	Swallow	2nd Magnesian Limestone (lower part)
1893	White	Magnesian series (lower part)
1894	**Winslow**	**Jefferson City limestone (lower part)**
		White River limestone (lower part; southwestern Missouri)
1898	Keyes	Winfield limestone (lower part)
1900	Gallaher	2nd Calciferous limestone (part)
1902	Keyes	King limestone
	Weeks	Jefferson City limestone ("Cambrian"; part)

1903	Ball and Smith	Jefferson City formation (lower part)
1911	Ulrich (a or b)	Jefferson City dolomite (lower part)
1915	**Ulrich (*in* Ulrich and Bassler)**	**Jefferson City formation (restricted to present definition**; unpublished manuscript)
1916	**Ulrich (*in* Purdue and Miser)**	**Jefferson City limestone (as presently defined, first published reference)**
1918	Tarr	Jefferson City formation (lower part)
	Branson	Jefferson City formation (lower part)
	Dake	Jefferson City formation (restricted)
1921	Dake	Jefferson City limestone of Jefferson City group
1924	Krey	Jefferson City group (lower part; "= Winfield limestone of Keyes")
1933	Oder	Knox dolomite (part)
1944	Branson	Jefferson City formation
	Cullison	Jefferson City group (lower part) Rich Fountain formation Rockaway conglomerate
1945	Grawe	Jefferson City formation
	Cloud	Rich Fountain formation
1950	Bretz	Cotter dolomite member of Jefferson City formation (lower part)
1957	Flower	"Jefferson City (Rich Fountain and Theodosia)"
1961	Martin et al. (a)	Jefferson City formation
1970	Kay	Rich Fountain Formation
1982	Amsden et al.	Kindblade Formation (in Oklahoma)
	Thompson	Jefferson City Dolomite
1991	**Thompson (present report)**	**Jefferson City Dolomite**

Remarks -- As described by Martin et al. (1961a, p. 23), the Jefferson City Dolomite in Missouri is mostly light-brown to medium-brown, medium- to finely crystalline dolomite and argillaceous dolomite. Chert, which is not abundant, is typically oolitic, banded, mottled, or sandy. The succession of lithologies is complex; for example, various types of dolomite are repeated, interbedded with dolomites of differing textures and structures. Some beds, often only 1 or 2 ft thick, are composed of highly brecciated chert and dolomite and can be used locally as marker beds for mapping. Lenses of orthoquartzite, conglomerate, and shale are locally present. Finely crystalline argillaceous dolomite, called "cotton rock," is characteristic of the Jefferson City and also of the overlying Cotter Dolomite. On the average, however, the Jefferson City contains more finely to medium-crystalline cryptalgal laminate dolomite than the overlying Cotter.

A thickly-bedded, massive, brown, medium-crystalline dolomite that weathers to a coarsely pitted surface is widely exposed in central Missouri. Informally designated the **"Quarry Ledge"** (figs. 23 and 24), it serves as a marker bed to define the approximate position of the Roubidoux-Jefferson City contact, 25 to 35 ft below the base of the "Quarry Ledge." It is well exposed in several roadcuts on I-44, in south-central Missouri (fig. 23). Rock obtained from the "Quarry Ledge" was formerly very popular as dimension stone.

Jefferson City strata below the "Quarry Ledge" are mostly "cotton rock," oolitic chert, sandy chert, and shales, and are usually poorly exposed.

The Jefferson City Dolomite is exposed around the periphery of the Ozark region (fig. 25) and on many divides between deeply incised river valleys. In all of northern, central, and western Missouri, the top of the Jefferson City is recognized in the subsurface by its characteristic oolitic chert. Because it is difficult to correlate units like the Jefferson City and Cotter in the subsurface by carbonate types, insoluble residue studies have identified many zones by chert types. Siliceous spicules also aid in studies of Canadian strata in the Midcontinent region. The Jefferson City is 125 to 350 ft thick; its average thickness is 200 ft but it is usually about 150 to 180 ft thick in central Missouri.

The contact with the underlying Roubidoux Formation is based on the lower content of quartz sand and chert in the Jefferson City, in contrast to the much higher amount of chert, usually oolitic, at the top of the

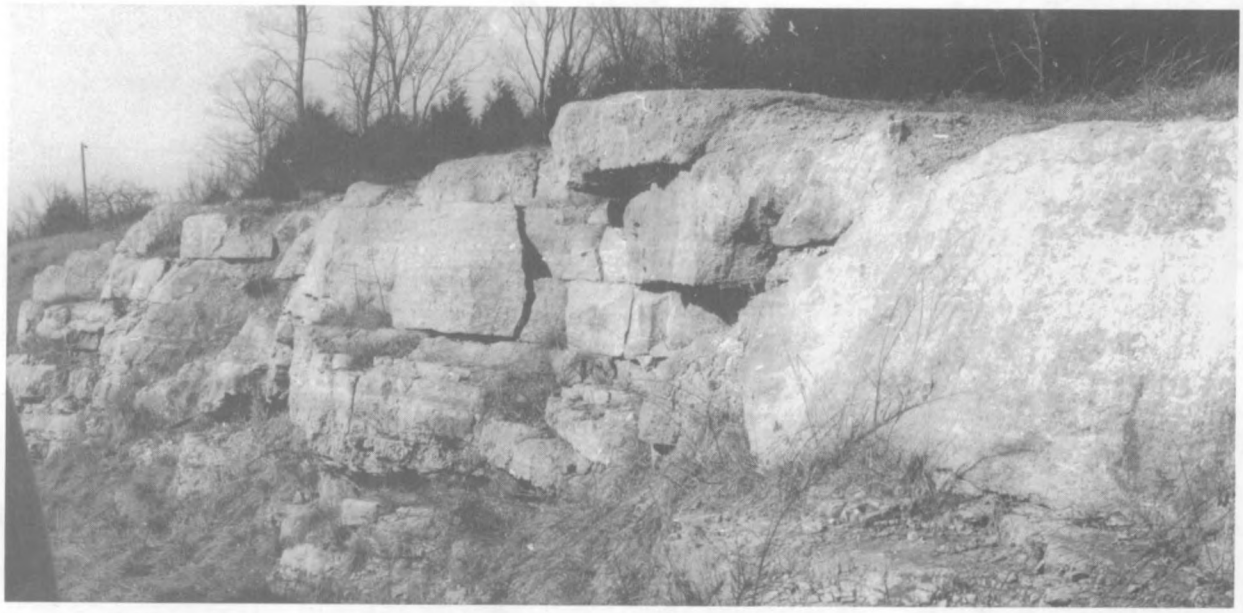


Figure 23 (A) ▲ Figure 23 (B) ▼

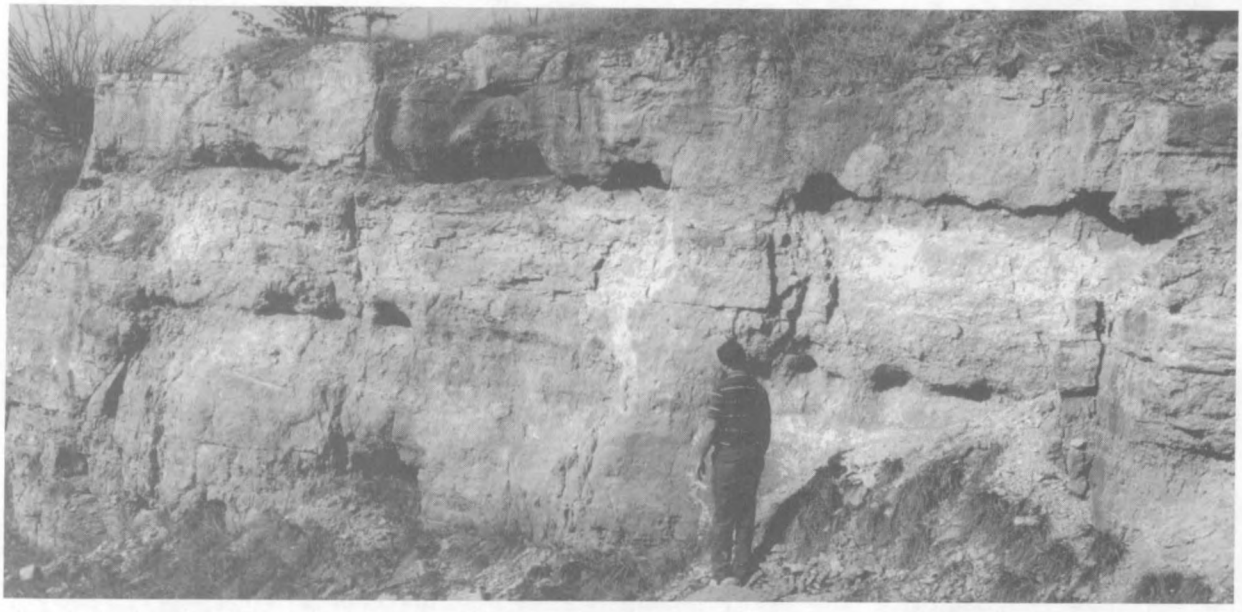


Figure 23. *The* **"Quarry Ledge"** *of the* **Jefferson City Dolomite** *in Pulaski County, Missouri.* **(A)** *Roadcut on I-44, NW¼ NE¼ sec. 17, T. 35 N., R. 13 W., Richland 7½' Quadrangle.* **(B)** *Roadcut on the west on ramp to I-44 at the Saint Robert exit (units 42 and 43, fig. 9), NE¼ NE¼ sec. 30, T. 36 N., R. 11 W., Waynesville 7½' Quadrangle. Photographs by T.L. Thompson.*

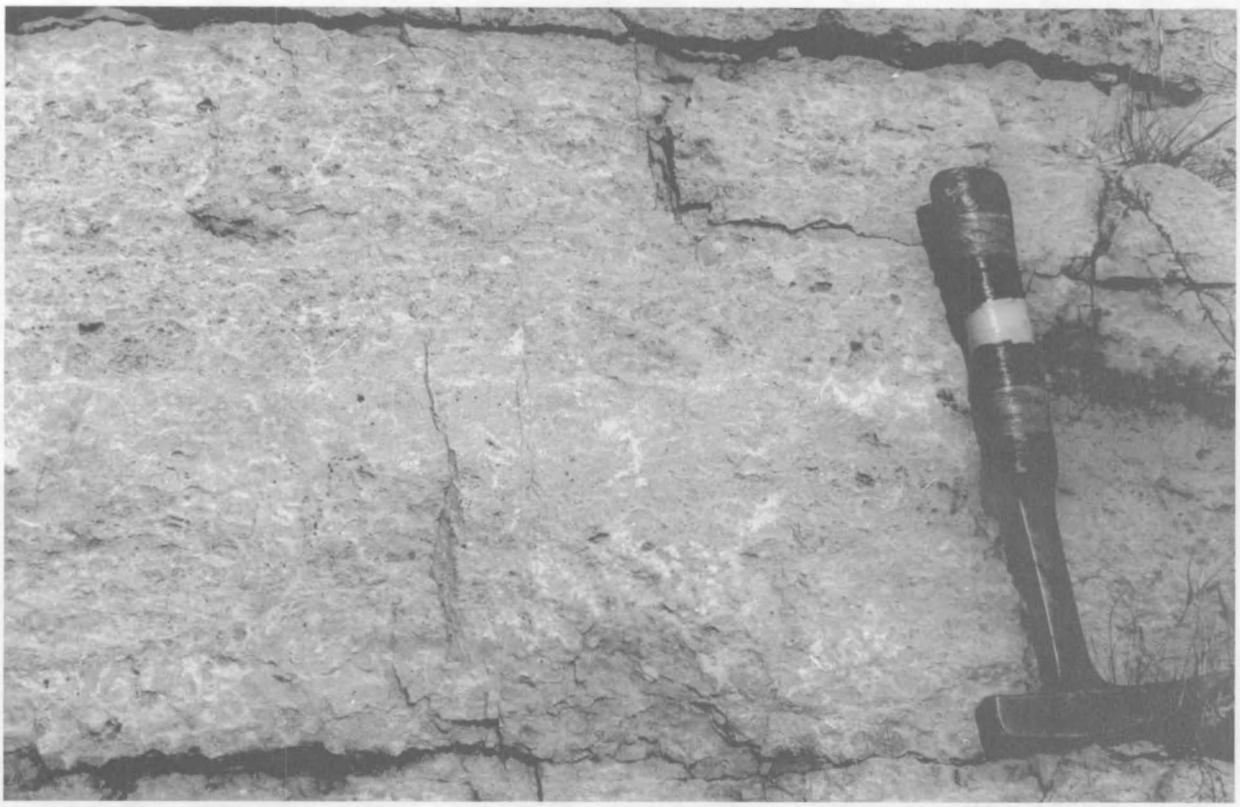


Figure 24. *Lithologic characteristics of the* **"Quarry Ledge,"** *a distinctive marker bed within the* **Jefferson City Dolomite,** *exposed in a roadcut on I-44, Pulaski County, central Missouri. Photograph by T.L. Thompson.*

Roubidoux. In many places, the interval to the "Quarry Ledge" serves to determine the approximate Roubidoux-Jefferson City contact. Because the contact with the overlying Cotter Dolomite is very difficult to determine, the formations are often combined as "Jefferson City-Cotter."

In portions of southwestern Missouri, a very cherty breccia zone, considered to be the top of the Jefferson City Dolomite, has been used to map the Jefferson City-Cotter contact. This bed is believed to represent the **"Rockaway conglomerate"** of Cullison (1944), which he used (fig. 29) to identify the boundary between his **Rich Fountain Formation of the Jefferson City Group** (Jefferson City Dolomite) and the overlying **Theodosia Formation of the Jefferson City Group** (Cotter Dolomite).

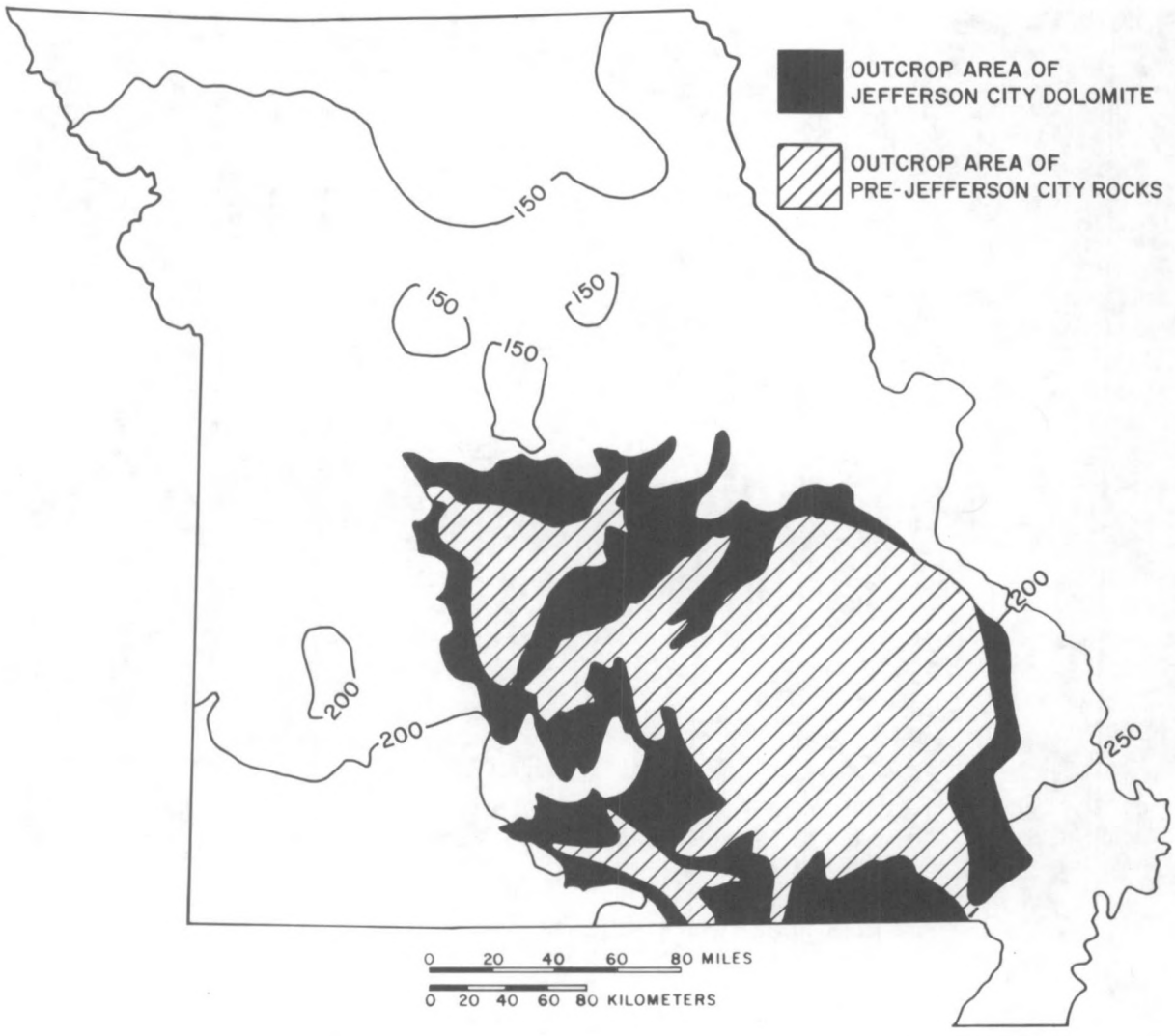


Figure 25. *Isopach map, distribution, and areas of outcrop of the* **Jefferson City Dolomite** *in Missouri. Isopach interval is 50 ft.*

Cotter Dolomite

Ulrich, *in* Purdue and Miser, 1916

Original description -- (Purdue and Miser, 1916, p. 4) "The Cotter dolomite, as the name implies, consists largely of dolomite, but it also contains some shale, chert, and sandstone. The formation is named by E.O. Ulrich from Cotter, Baxter County, Ark., where it is well exposed..."

"The formation consists mainly of two kinds of dolomite; a fine-grained argillaceous, earthy-textured, relatively soft, white to buff or gray variety, known as 'cotton rock,' and a more massive medium-grained gray variety that weathers hackly on the surface and becomes dark on exposure. These two sorts occur in beds ranging from a few inches to 4 ft in thickness and are interbedded with each other and with thinner layers of sandstone, shale, and some chert. The lime and magnesia constituting the greater part of the dolomite occur in almost the exact proportion in which they are found in true dolomite..."

"Sandstone and shale form but a small part of the formation. The sandstone occurs in the dolomite as streaks, most of which are not more than half an inch thick, and as layers, few of which exceed 2 ft in thickness. It is saccharoidal, and the surfaces of both the streaks and the heavier layers are generally finely ripple marked. The lower surface of many of these sandstone layers shows the casts of well-developed sun cracks that were formed in the underlying layers of calcareous mud before the sand was deposited. The shale consists of a few thin green beds, which weather to fine scales..."

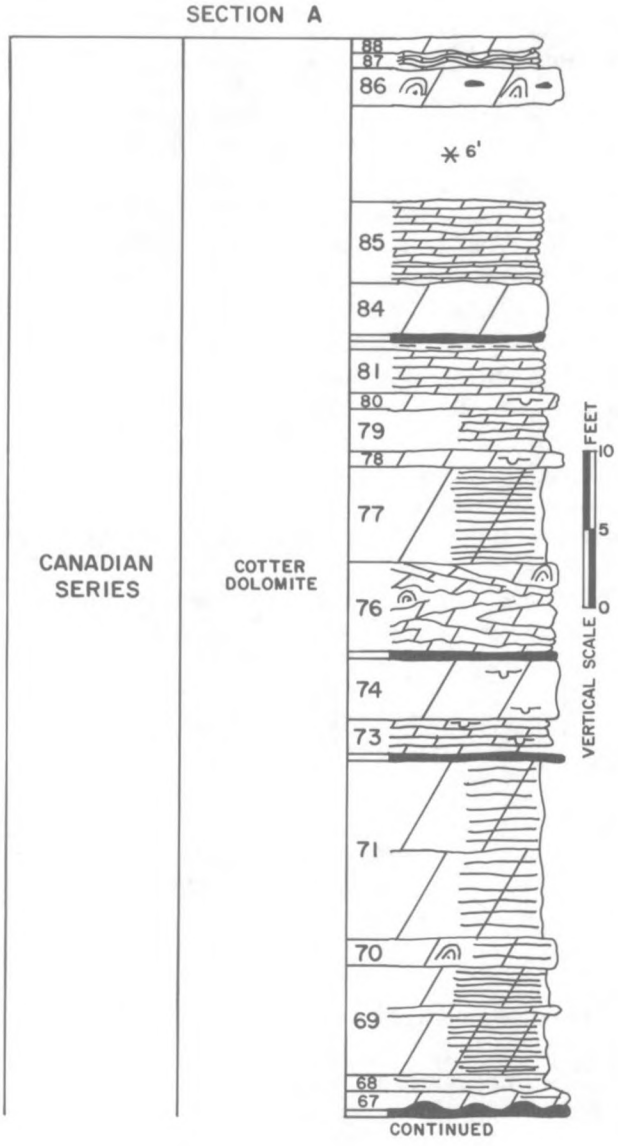
"...The masses of chert known as *Cryptozoon minnesotense* are common and are everywhere striking. Though they occur in Missouri and farther east in Arkansas, as well as in the underlying Jefferson City limestone, the upper range of the silicified, reef-building, coral-like plants, which these chert masses are supposed to represent, is the base of the succeeding Powell limestone. They are therefore of unfailing value in...determining that the rock containing them belongs to the Cotter dolomite. The other fossils consist chiefly of gastropods, the remainder being cephalopods."

Type section -- Purdue and Miser (1916) described the type section of the Cotter as "Starting at valley bottom just upstream from west end of White River at Cotter and extending to top of hill westward along n.s. Highway 62 [sec. 31, T. 19 N., R. 14 W., Cotter 7½' Quadrangle], Baxter Co., Ark." Unfortunately the lower part of the Cotter, and thus the contact with the underlying Jefferson City Dolomite, is not present within the type area of the Cotter.

Reference sections -- Like the Jefferson City Dolomite, the Cotter is exposed extensively throughout southern Missouri, although contacts with the underlying Jefferson City and overlying Powell are often difficult to identify. Excellent exposures of the Cotter Dolomite occur in roadcuts on U.S. Highway 65, south of Springfield, in Christian and Taney counties (figs. 26 and 27).

History of nomenclature

1855	Swallow	2nd Magnesian Limestone (middle part)
1873	Pumpelly	2nd Magnesian limestone (middle part; "Buhrstone beds")
1893	White	Magnesian series (upper part)
1894	Winslow	Jefferson City limestone (middle part) White River limestone (middle part; southwestern Missouri)
1898	Keyes	Winfield limestone (upper part)
1900	Gallaher	3rd Calciferous limestone Moreau sandstone (part; upper sandstone)
1903	Ball and Smith	Jefferson City formation (upper part)
1904	Buckley and Buehler	Jefferson City formation (middle part)
1905	Adams and Ulrich	Yellville formation (lower part)
1911	Ulrich	Jefferson City dolomite (middle part; "Yellville group")
1915	**Ulrich (*in* Ulrich and Bassler)**	**Cotter formation (first description**; unpublished manuscript)
1916	**Ulrich (*in* Purdue and Miser)**	**Cotter formation (first published description)**
1918	Branson	Jefferson City formation (middle part)



Section A

ORDOVICIAN SYSTEM - CANADIAN SERIES
Cotter Dolomite

88. Dolomite, light-brown, highly weathered. (1 ft)
87. Dolomite, light-grayish-tan, mudstone, weathers platy and slabby; top very irregular. (1 ft)
86. Dolomite, light gray, medium-crystalline grainstone, stromatolitic, single bed; scattered small brown chert nodules. (2.5 ft)

Covered interval. (5 ft)

85. Dolomite, tan, laminated, thin bedded, slabby; top forms uppermost bench in west roadcut. (10 ft)
84. Dolomite, light-gray, finely to medium-crystalline packstone, burrowed, medium bedded. (3 ft)
83. Chert, small oolites. (0.5 ft)
82. Shale, bluish-gray, dolomitic, platy; forms prominent reentrant near top of roadcut. (0.5 ft)
81. Dolomite, light-brown, mudstone, thin irregular beds. (2.5 ft)
80. Dolomite, light-brown, mudstone to finely crystalline packstone, burrowed; quartz-druse-lined voids. (1 ft)
79. Dolomite, light-brown, mudstone, laminated, weathers to thin slabby beds; quartz-druse-lined voids. (2.5 ft)
78. Dolomite, light-brown, mudstone to finely crystalline packstone, burrowed, porous. (1 ft)
77. Dolomite, light-brown, mudstone, well laminated, laminations closer toward top, becoming hackly toward top. (6 ft)
76. Dolomite, tan to light-gray; interbedded slabby tan mudstone with well developed lenses of stromatolitic light gray medium-crystalline grainstone or packstone. (5.5 ft)
75. Chert, very oolitic. (0.25 ft)
74. Dolomite, light grayish-brown, finely crystalline packstone to mudstone, burrowed; quartz-druse-lined voids in mudstone. (4 ft)
73. Dolomite, light-brown mudstone to finely crystalline packstone, burrowed, thin slabby beds. (2 ft)
72. Chert, sandy, porous. (0.25 ft)
71. Dolomite, light-brown, mudstone, laminated; "cotton rock." (10.5 ft)
70. Dolomite, light-brown, finely crystalline packstone top and base; middle part gray medium-crystalline stromatolitic grainstone. (2 ft)
69. Dolomite, light-brown, argillaceous to silty, slabby bedded, laminated mudstone; thin 0.5 ft light-gray silty finely crystalline packstone 2.5 ft below top. (7.5 ft)
68. Shale, olive green, dolomitic, silty; forms prominent reentrant. (0.5-0.75 ft)
67. Dolomite, light-brown, mudstone, laminated; "cotton rock"; very irregular top and base. (1-1.5 ft)
66. Chert, smooth, very nodular; small greenish-gray oolites. (0.5 ft)

Figure 26. **Cotter Dolomite** *exposed in roadcuts on U.S. Highway 65, 12 mi north of Branson, Taney County, southwestern Missouri, Day 7½' Quadrangle. Section* **(A)** *- W½ NE¼ SE¼ sec. 20, T. 24 N., R 21 W., south of bridge over Bear Creek; section* **(B)** *- beginning center N½ NE¼ sec. 20 and extending to center north line N½ SE¼ sec. 17, T. 24 N., R. 21 W., north of bridge over Bear Creek. Approximately 310 ft of Cotter are exposed. Described in 1986 by C.E. Robertson and T.L. Thompson.*

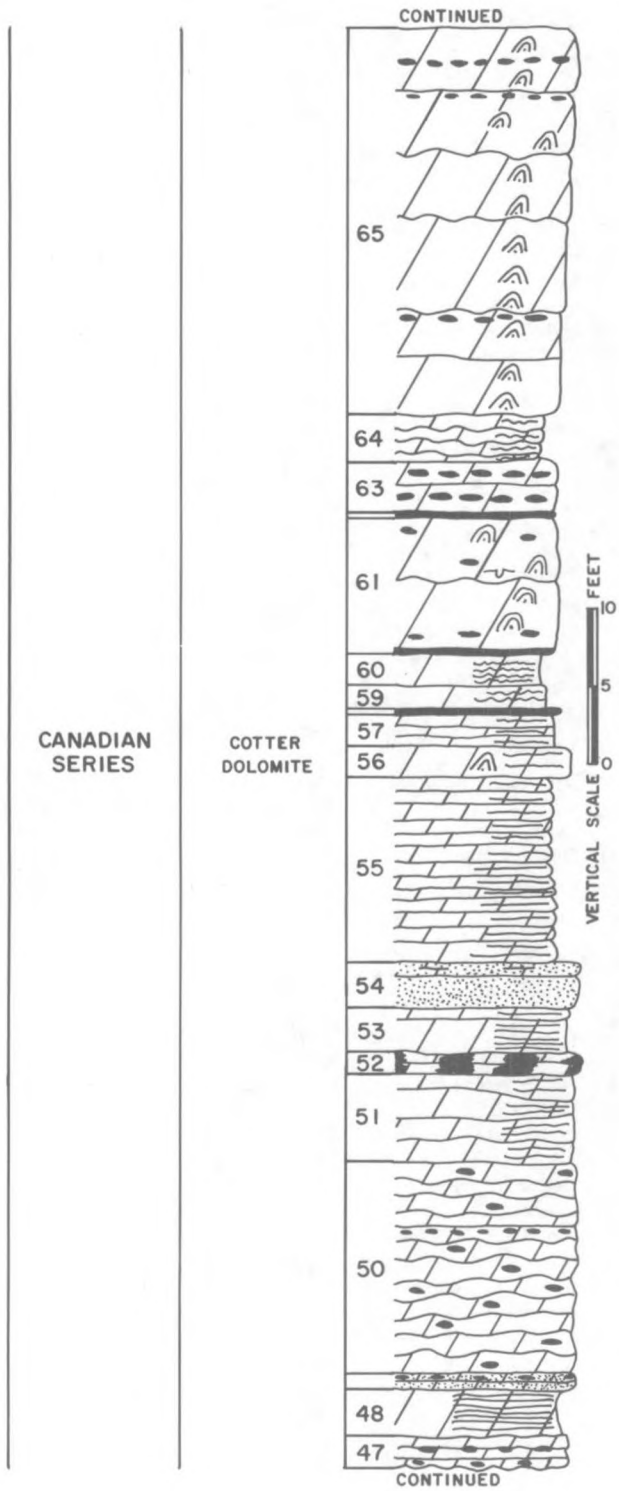


Figure 26 (cont.)

65. Dolomite, gray to light-brown, medium-crystalline grainstone to packstone, massive, thick stromatolitic beds; single bed of discontinuous chert nodules in middle of uppermost bed, small oolitic nodules in top of second bed 4 ft from top of unit, and zone of thin white oolitic chert 3 ft above base. (23 ft)
64. Dolomite, light-brown, mudstone to finely crystalline packstone, burrowed; thin irregular to hackly bedding. (3 ft)
63. Dolomite, light-brown, finely crystalline packstone, longitudinal chert stringers and oolitic chert nodules. (3 ft)
62. Chert, greenish-gray; oolites and "free oolites." (0.25 ft)
61. Dolomite, light gray, medium crystalline grainstone, stromatolitic, burrowed in places; two beds with irregular contact; *Ceratopia* near base; scattered oolitic chert nodules; thin continuous bed of chert at base with smooth gray oolites. (8.5 ft)
60. Dolomite, blue-gray, mudstone, irregular or wavy laminae; lower 0.5 ft light brown. (2 ft)
59. Dolomite, light-brown, mudstone to finely crystalline packstone, laminated, cherty. (1.5 ft)
58. Chert and sandy chert breccia. (0.25 ft)
57. Dolomite, light-brown, mudstone, laminated, thin blocky bedding; ripple marks at top. (2 ft)
56. Dolomite, light gray, interbedded laminated mudstone, and slightly conglomeratic, stromatolitic medium-crystalline packstone to grainstone. (2 ft)
55. Dolomite, light-brown, mudstone to finely crystalline packstone, laminated, thin- to medium-bedded; contains thin shale partings becoming more numerous upward; quartz-druse-lined voids. (12 ft)
54. Sandstone, quartzitic; dolomitic and slightly fossiliferous in upper 1 ft (**Swan Creek sandstone**). (3 ft)
53. Dolomite, blue-gray, mudstone, finely laminated; upper 6 in. nodular; quartz-druse-lined voids. (3 ft)
52. Chert, white, oolitic, and interbedded blotchy tan dolomite; base irregular. (1-1.5 ft)
51. Dolomite, blue-gray, mudstone and silty mudstone, laminated; very irregular and uneven beds; interbedded shale seams. (5.5 ft)
50. Dolomite, finely to medium-crystalline grainstone and packstone, very irregular beds, stromatolitic in middle 3 ft; chert, as scattered numerous small nodules; prominent banded chert bed with brown and gray oolites on top of stromatolitic zone, 4 ft below top of unit; upper 4 ft less cherty. (13 ft)
49. Sandstone and dolomitic sandstone; cherty at top, quartzitic. (1 ft)
48. Dolomite, dark-gray and brown, mudstone, prominently laminated; forms reentrant; wavy base. (2.5 ft)
47. Dolomite, light-brown, finely to medium-crystalline packstone, blocky bedding; shaly toward top; scattered nodules of transluscent banded chert; unit wavy bedded. (2 ft)

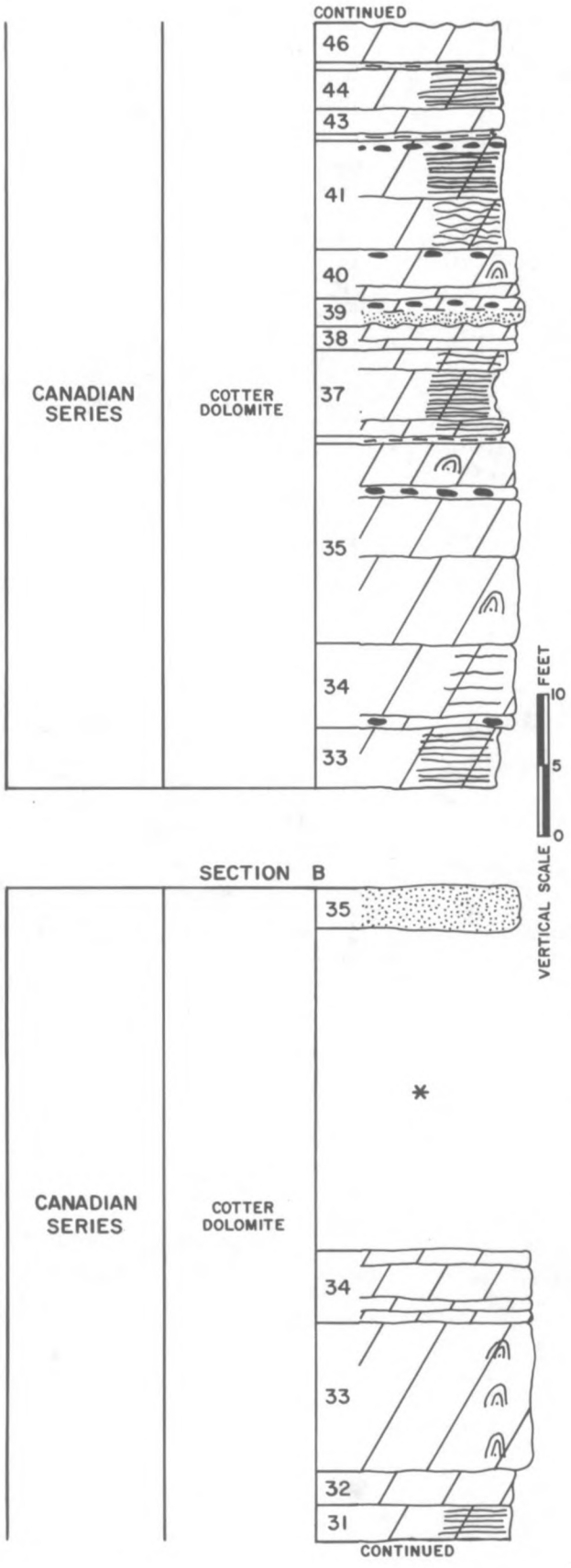


Figure 26 (cont.)

46. Dolomite. light gray-brown, mudstone, no laminae; featureless. (3 ft)
45. Shale, dolomitic, with frosted sand grains. (0.25 ft)
44. Dolomite, light-gray and brown laminated mudstone. (2.5 ft)
43. Dolomite, gray-blue, poorly laminated, "birdseye" structures. (2 ft)
42. Shale, grayish to red brown. (0.25 ft)
41. Dolomite, blue-gray, mudstone, wavy and nodular laminated, weathers slabby; upper half more evenly laminated; abundant quartz-druse-lined voids; zone of chert nodules at top. (7.5 ft)
40. Dolomite, light-gray, finely to medium-crystalline grainstone, stromatolitic upper 2.5 ft; brown chert nodules at top; two beds. (3.5 ft)
39. Sandstone, dolomitic, cross-bedded; base irregular; oolitic sandy chert upper 0.1 ft; interbedded sandstone and dolomitic sandstone or sandy dolomite. (1.5 ft)
38. Dolomite, gray, medium-crystalline grainstone, irregular top. (1 ft)
37. Dolomite, blue-gray, mudstone; upper 1.5 ft blocky, coarsely laminated, middle 3.5 ft more shaly, finely and strongly laminated, lower 1 ft brown, coarsely laminated mudstone; prominent marker bed for miles. (6 ft)
36. Shale, dolomitic, reentrant. (0.25 ft)
35. Dolomite, light gray, medium-crystalline grainstone and packstone, partly stromatolitic, partly burrowed; two chert zones, one of deciminated chert in dolomite 3 ft below top, one band of transluscent brown oolitic chert 5 ft above base. (13 ft)
34. Dolomite, light-brown, mudstone, poorly laminated; single prominent vertical face; correlates with unit 34 on Section B; lower 1 ft transitional with unit 33. (5.5 ft)
33. Dolomite, light-brown, mudstone, fine wavy laminae; base of western roadcut. (4 ft)

SECTION B

ORDOVICIAN SYSTEM - CANADIAN SERIES
Cotter Dolomite

35. Sandstone, as ledge and float at top of hill above roadcut. (1 ft)

Covered interval; finely crystalline dolomite mudstone in discontinuous slabby ledges; partly exposed. (15 ft)

34. Dolomite, light-brown, very finely crystalline packstone, faint horizontal laminae; very distinctive unit, straight even uniform face; small band of elongate chert nodules in basal 1 ft; correlates with unit 34 on Section A. (5 ft)
33. Dolomite, medium-crystalline grainstone, stromatolitic; essentially one bed. (12 ft)
32. Dolomite, light-brown, mudstone, weakly laminated. (2.5 ft)
31. Dolomite, light-brown, like unit 32, more prominent horizontal laminae. (2.5 ft)

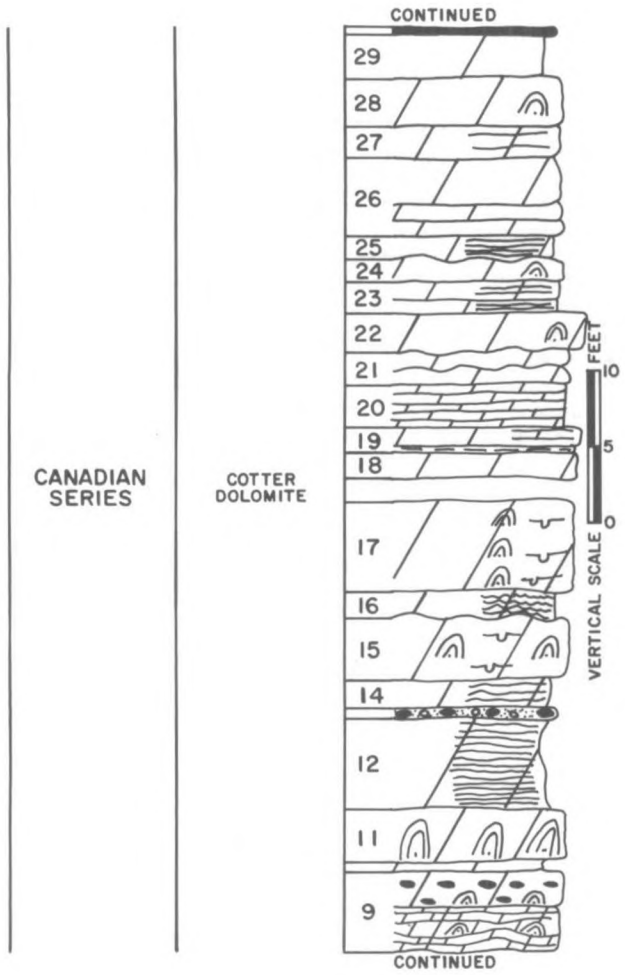


Figure 26 (cont.)

30. Chert, smooth, gray, and interbedded tan dolomite; gastropods in chert. (0.25 ft)
29. Dolomite, light-brown, mudstone, laminated. (2.5 ft)
28. Dolomite, gray, coarsely crystalline grainstone, stromatolitic; single bed. (2.6 ft)
27. Dolomite, light-tan, finely crystalline packstone, laminated. (2.25 ft)
26. Dolomite, gray, medium-crystalline grainstone, even bedded, upper 2.5 ft thick bedded. (5 ft)
25. Dolomite, light-brown, mudstone, finely laminated; irregular basal contact with unit 24; small quartz-druse-lined voids; laminae weather to incipient thin parallel beds. (2 ft)
24. Dolomite, light-brown, medium-crystalline grainstone, stromatolitic. (1 ft)
23. Dolomite, light-brown to blue-gray, mudstone, laminated; upper 1.5 ft light brown, blocky, lower 1 ft blue-gray, more finely laminated; laminae weather to thin parallel incipient beds. (2.5 ft)
22. Dolomite, light-gray, medium-crystalline grainstone, stromatolitic; some depositional breccia. (2.5 ft)
21. Dolomite, light-brown, mudstone, irregularly but thick bedded, laminated. (2 ft)
20. Dolomite, light-brown, mudstone, laminated; thin slabby beds. (2.5 ft)
19. Dolomite, light-brown, mudstone, single bed, laminated; weathers slabby; weathered band of chert in lower part. (1 ft)
18. Dolomite, light-brown, mudstone, single bed, little or no laminae. (1.5 ft)

Covered interval 1-2 ft

17. Dolomite, gray, medium-crystalline grainstone, stromatolitic; single massive bed. (6 ft)
16. Dolomite, light-brown, mudstone, laminated; irregular top and base; incipient nodular to slabby bedding. (1.5-2 ft)
15. Dolomite, gray, finely to medium-crystalline grainstone or packstone, uneven top, burrowed, stromatolitic; partially brecciated; single massive bed. (4 ft)

Beds 15-35 in next roadcut north (3rd) from bridge.

14. Dolomite, light-brown, mudstone, laminated, blocky. (2 ft)
13. Chert, oolitic; and dolomite, light-brown, sandy in upper half. (0.5 ft)
12. Dolomite, yellow-brown, mudstone, finely and prominently laminated with dark brown to red brown laminae; weathers on laminae to flat slabs or chips; poorly resistant. (6 ft)

Section below in first roadcut north of bridge over Bear Creek.

11. Dolomite, dark-brown, coarsely crystalline grainstone, prominent digitate stromatolites; very even top and base; very unique bed. (3 ft)
10. Dolomite, blue-gray, shaly mudstone, finely laminated; forms reentrant. (0.75 ft)
9. Dolomite, light-brown to gray, mudstone to medium-crystalline grainstone or packstone, partially stromatolitic; upper 2 ft bed contains large brown nodules of oolitic chert; lower 3 ft bed, separated by a thin shale seam from the upper bed, contains slabby to massive medium-crystalline stromatolitic grainstone or packstone separated by thin undulating to nodular beds of mudstone. (5 ft)

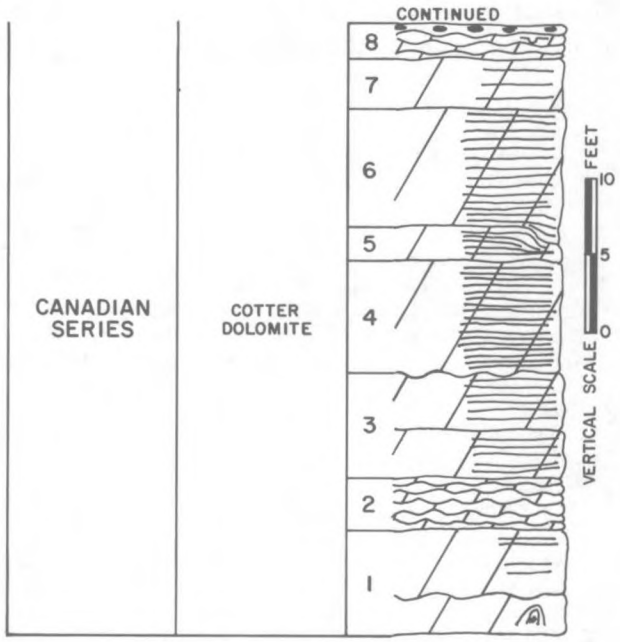


Figure 26 (cont.)

8. Dolomite, light-brown, mudstone, laminated to banded, and possibly burrowed, irregular, hackly bedding; small row of chert nodules at top 1-2 in. (2 ft)
7. Dolomite, blue-gray, mudstone, laminated, weathers blocky; top irregular; small quartz-druse-lined voids. (6 ft)
6. Dolomite, blue-gray, mudstone, prominently laminated, more shaly toward base; laminae more closely spaced toward base; base very irregular on unit 5. (7.5-8 ft)
5. Dolomite, blue-gray, mudstone, very prominently laminated or planar-stromatolitic; small quartz-druse-lined voids; top irregular; "ribbon rock." (2-2.5 ft)
4. Dolomite, blue-gray to bluish-tan, mudstone, closely and prominently laminated; irregular base; small quartz-druse-lined voids; lower 0.5 ft silty. (7 ft)
3. Dolomite, light-brown, mudstone, silty, coarsely laminated, weathers smooth and rounded; top irregular; small quartz-druse-lined voids. (6 ft)
2. Dolomite, light-brown, mudstone, thin slabby to hackly nodular beds; laminated; small quartz-druse-lined voids. (3 ft)
1. Dolomite; upper 4 ft light-brown mudstone, laminated, small quartz-druse-lined voids, weathers smooth and rounded; lower 2.5 ft finely to medium-crystalline grainstone, possibly stromatolitic; top irregular. (2.5 ft)

Base of exposure 10 ft ± above Jefferson City - Cotter contact (breccia zone)

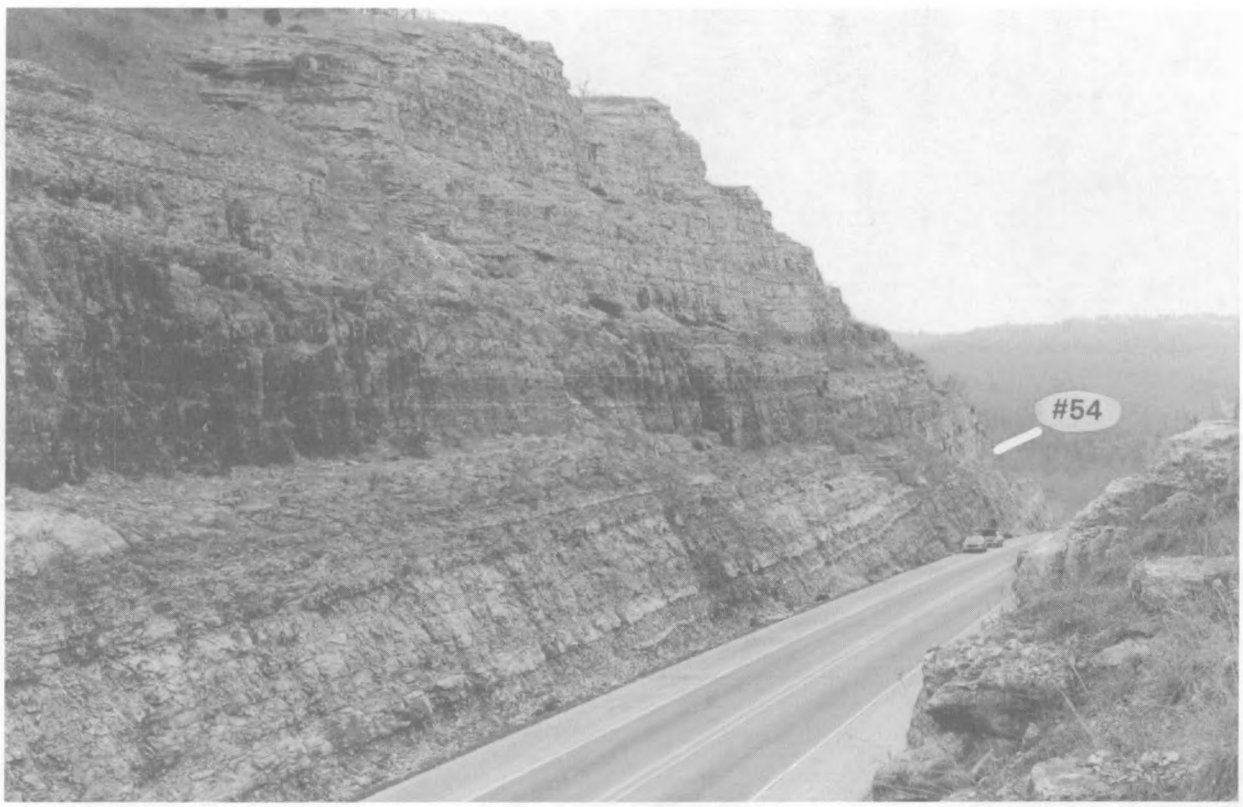


Figure 27. **Cotter Dolomite** *exposed in a roadcut on U.S. Highway 65 (section A, fig. 26) in the W½ NE¼ SE¼ sec. 20, T. 24 N., R. 21 W., Taney County, Missouri. Unit 54 of the measured section is marked on the photograph. Photograph by T. L. Thompson.*

1921	Dake	Cotter limestone of Jefferson City group
1924	Krey	Jefferson City group (middle part; "= Winfield limestone of Keyes")
1928	Weller and St. Clair	Cotter formation
1933	Oder	Knox dolomite (upper part)
1944	Cullison	Jefferson City Group (upper part) Cotter Formation Theodosia Formation Blackjack Knob Member Gainesville sandstone Lutie Member Hercules Tower sandstone (= Swan Creek sandstone of Cotter Dolomite)
1945	Cloud	Theodosia formation
1961	Martin et al. (a)	Cotter formation "Swan Creek sandstone"
1964	Harlton	Cool Creek Formation (in Oklahoma; upper part; "equivalent to Cotter of Ozark Mountains of Missouri")
1967	Yochelson and Saunders	Sac limestone
1970	Kay	Theodosia Formation
1971	Fellows et al.	Cotter Dolomite Swan Creek Sandstone
1976	Hedden	Cotter Dolomite Bull Shoals Member Blackjack Knob Member Lutie Member
1982	Thompson	Cotter Dolomite
1991	**Thompson (present report)**	**Cotter Dolomite**

Remarks -- Although the Cotter Dolomite was first described by Purdue and Miser (1916), who cited it as "named by E.O. Ulrich," Bassler (1915) listed the name "Cotter limestone" on his correlation charts but did not explain the origin of the name. Purdue and Miser (1916, p. 4) stated,

> "The name Yellville was applied in 1904 and again in 1905 by G.I. Adams and E.O. Ulrich to strata that have subsequently been separated into what are herein known as the Cotter dolomite and the Powell limestone, the limestone overlying the dolomite. In 1911 Ulrich called the Cotter the Jefferson City dolomite, but in 1912 he determined that the beds he called Jefferson City in the Eureka Springs and Harrison quadrangles are younger than this formation at the type locality. This name, therefore, is not applicable to these areas, and for this reason the name Cotter is applied."

In Missouri (fig. 28), the Cotter Dolomite mostly comprises light-gray to light-brown, medium- to finely crystalline, chert-free, and cherty dolomite. Detailed descriptions show the Cotter Dolomite consists of zones of laminated dolomite mudstone alternating with thin to thick zones of cryptalgal, fine- to medium-crystalline dolomite. Overall, the Cotter is normally thin to medium bedded and contains thin intercalated beds of green shale and sandstone. Bedding in the mudstones is often very thin and uniform (2 to 6 in. thick); outcrops often resemble masonry walls. A sandstone, 15 to 20 ft thick in the Springfield area, 4 to 7 ft thick near Branson, southwestern Missouri, has been named the **Swan Creek sandstone**. At this time, however (1991), the Swan Creek is not formally recognized as a member, because it is discontinuous and may be confused with other sandstone beds at different stratigraphic positions in the Cotter. The Swan Creek may be equivalent to the **Hercules Tower sandstone** of Cullison (1944).

The Cotter Dolomite near the Missouri-Arkansas border of south-central Missouri was identified as two formations by Cullison (1944); the upper the Cotter Formation, and the lower the **Theodosia Formation** (fig. 29).

The Cotter of Cullison was equivalent to the type Cotter section, and the Theodosia, named from exposures near the town of Theodosia, Ozark County, Missouri, corresponded to the part of the lower Cotter

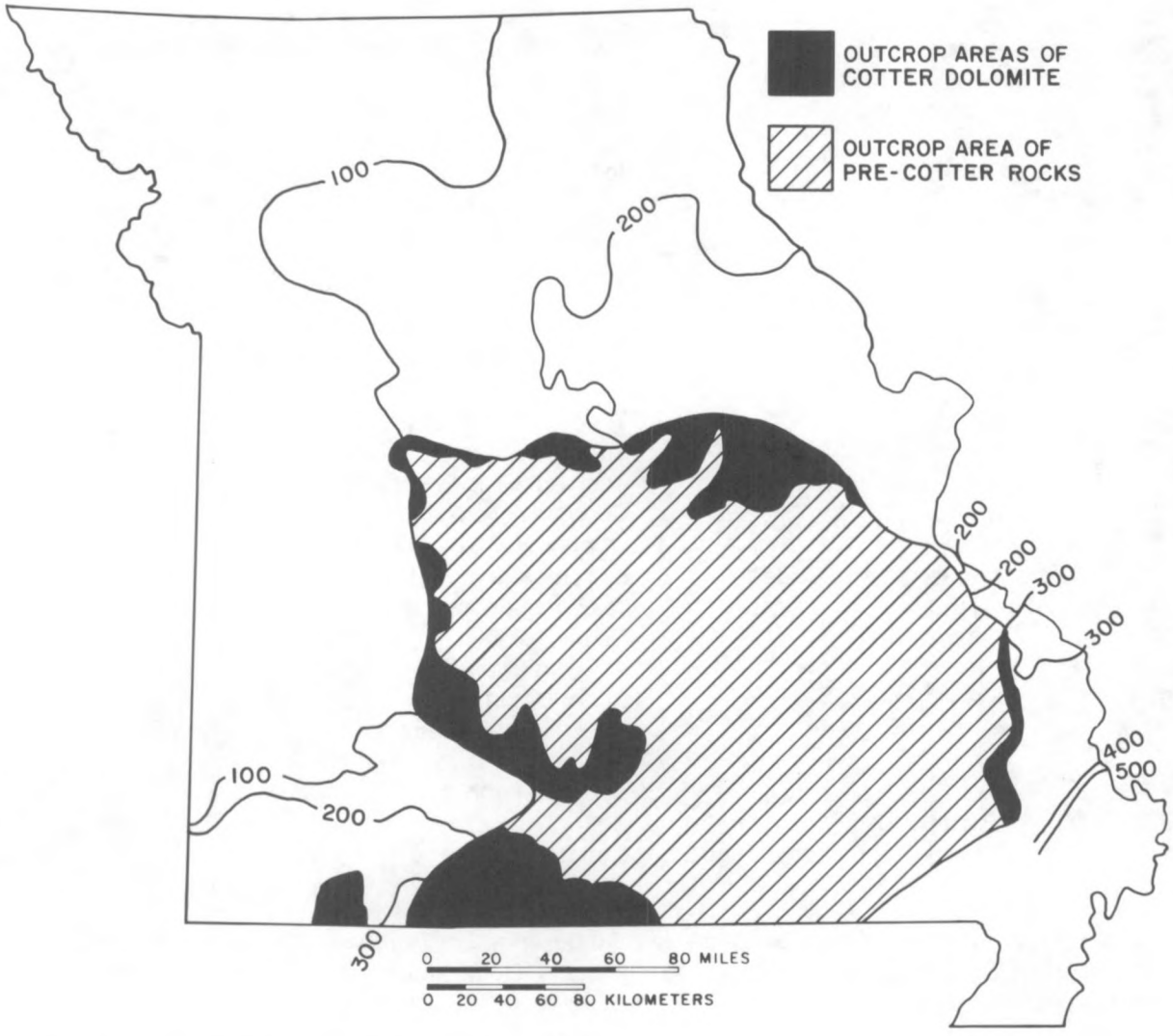


Figure 28. *Isopach map, distribution, and areas of outcrop of the* **Cotter Dolomite** *in Missouri. Isopach interval is 100 ft.*

that is unexposed in the type area of the Cotter. Cullison (1944) recognized two members of the Theodosia (what is now the lower Cotter Dolomite) in south-central and southwestern Missouri; a lower **Lutie Member** and an upper **Blackjack Knob Member**. Above the Blackjack Knob Member, the remainder of the Cotter (which could be considered a third member), was not named, and called only "Cotter." Hedden (1976) identified the Lutie and Blackjack Knob Members, and named the overlying upper Cotter the **Bull Shoals Member**. Although these members have not been formally recognized as part of the Cotter throughout Missouri, they have proved useful in mapping in the region in which they were originally defined, *i.e.*, southwestern and south-central Missouri.

In a general sense, Martin et al. (1961a, p. 23) stated the following:

> "The lower part of the Cotter formation is relatively noncherty and contains echinoderm fragments, the middle part is characterized by oolitic chert and large siliceous ooliths, and the upper part is shaly and contains small quartz masses and brown quartzose oolitic chert.
>
> "The Cotter is conformable on the underlying Jefferson City, and because it is difficult to differentiate the two formations they are often designated as a combined unit, as Jefferson City-Cotter."

Purdue and Miser (1916, p. 5) stated that in northwestern Arkansas

> "The Powell limestone rests unconformably upon the rather uneven eroded surface of the Cotter dolomite..."

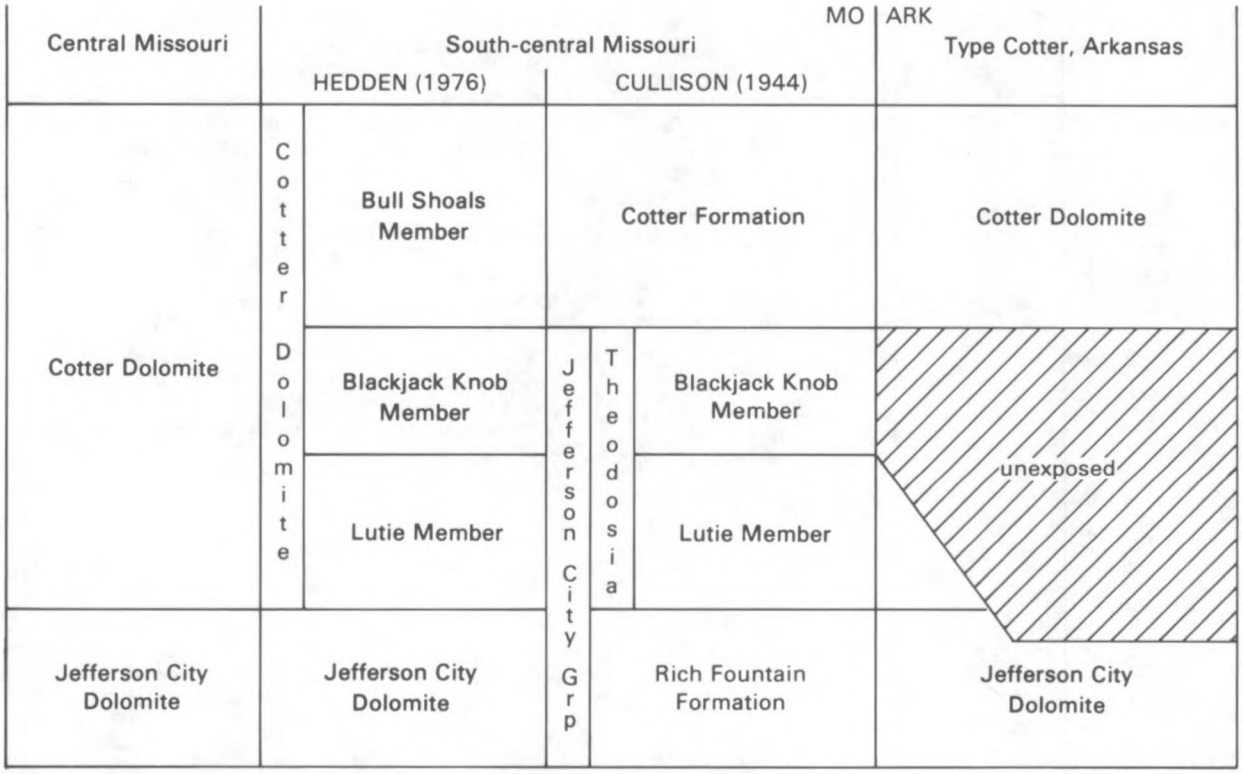


Figure 29. *Chart of* **Cotter Dolomite** *from the type area in north-central Arkansas to central Missouri, comparing nomenclature proposed by Cullison (1944) and Hedden (1976).*

Weller and St. Clair (1928, p. 80) described this contact in eastern Missouri as unconformable:

> "In some localities distinct evidence of pre-Powell erosion is exhibited, although elsewhere such evidence of unconformity is slight."

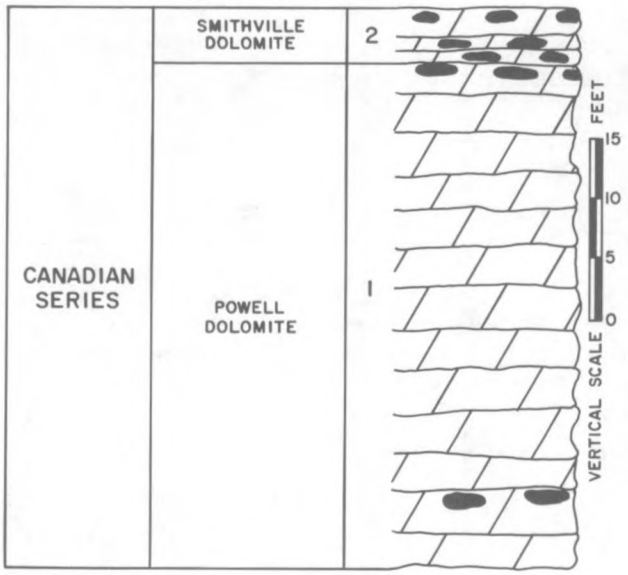
Martin et al. (1961a, p. 24) concluded,

> "The Cotter crops out along the northern, western [and southwestern] edges of the Ozark uplift and is present in the subsuface except where it has been removed by pre-St. Peter erosion in west-central and northwestern Missouri. The average thickness of the Cotter is 200 ft, but its maximum thickness of 450 ft is in the subsurface of southeastern Missouri. The Cotter is absent in St. Clair County where the Mississippian lies unconformably on the Jefferson City formation."

Powell Dolomite

Ulrich, *in* Purdue and Miser, 1916

Original description -- (Purdue and Miser, 1916, p. 5) "The Powell limestone...consists of magnesian limestone, a small amount of shale, and at most places a bed of conglomerate at the base. The conglomerate is a dark argillaceous magnesian limestone, containing pebbles of chert and limestone derived from the Cotter dolomite. At a few places it includes a layer that seems to be a part of an old residual mantle recementing in place and containing lenses of chert and silicified masses of *Cryptozoon minnesotense*... With the exception of one or more beds of calcareous green shale, the formation consists of finely crystalline gray or greenish-gray magnesian limestone, containing more or less argillaceous matter...The exposed layers do not as rule present hackly surfaces but are somewhat rounded, and at many places they break with a conchoidal fracture into small angular pieces. More or less concentrically banded, dense white chert in the form of small nodules is sparingly distributed through the limestone. This formation resembles certain beds, known as 'cotton rock,' in the Cotter dolomite, but the small amount of chert throughout the formation



ORDOVICIAN SYSTEM - CANADIAN SERIES

Smithville Dolomite

2. Dolomite, finely crystalline, thin- to massively bedded; highly weathered producing tripolitic chert; entire unit is very cherty, containing abundant large "bulls-eye-like" chert nodules; quartz druse commonly fills small cavities; top of unit weathers to a nodular surface, and entire unit is extremely weathered and "rotten" in appearance. Base of unit marked by a 4- to 6-in. green shale bed, which may represent the base of the Smithville Dolomite. (4-5 ft)

Powell Dolomite

1. Dolomite, chocolate brown, finely crystalline, dense, massively bedded; weathers buff; small calcite-filled cavities common throughout; "bulls-eye-like" chert nodules approximately 5 ft above base and immediately below top; zones of highly burrowed dolomite at northern end of cut, along with small-scale faulting; small iron oxide fillings (limonite) common throughout. (41 ft)

Figure 30. *Exposure of* **Powell Dolomite (Pw)** *and the basal beds of the* **Smithville Dolomite (Sv)** *on I-55 in the SW¼ SW¼ sec. 13 (projected), T. 38 N., R. 7 E., between the bridges over Establishment and Fourche du Close Creeks, in Ste. Genevieve County, southeastern Missouri, Weingarten 7½' Quadrangle; mileage 156.9. Adapted from a description by Thacker and Satterfield (1977). Photograph by T.L. Thompson.*

and the absence, except in the basal conglomerate, of the cherty masses of *Cryptozoon minnesotense* are generally sufficient to distinguish this limestone from the Cotter..."

"A bed containing much drusy quartz and outcropping as a single massive dark ledge with a rough surface occurs in the lower half of the formation in the eastern and southern portions of the Harrison quadrangle [northwestern Arkansas]."

Type section -- Purdue and Miser (1916, p. 5) stated that "The formation was named by E.O. Ulrich from Powell station, on the White River branch of the St. Louis, Iron Mountain & Southern Railway, where it is well exposed." Powell station, originally located about 2 mi down Crooked Creek from the present village of Pyatt, Marian County, Arkansas, is abandoned, and the railroad is now the Missouri-Pacific Railway. This is in secs. 4 to 6, T. 18 N., R. 17 W., Bruno 7½' Quadrangle.

Reference section -- The Powell Dolomite has previously been identified in parts of southwestern Missouri, overlying the lithologically similar Cotter Dolomite, and in the subsurface of southeastern and east-central Missouri. Powell and basal Smithville strata have been identified in roadcuts on I-55 (fig. 30) in the SW¼ SW¼ sec. 13 (projected), T. 38 N., R. 7 E., Ste. Genevieve County, southeastern Missouri, Weingarten 7½' Quadrangle. This exposure was described by Thacker and Satterfield (1977, p. 63).

History of nomenclature

1855	Swallow	2nd Magnesian Limestone (upper part)
1894	Winslow	Jefferson City limestone (upper part) White River limestone (upper part; southwestern Missouri)
1898	Keyes	Winfield limestone (upper part)
	Shepard	2nd Magnesian limestone (upper part) Sac limestone
1900	Gallaher	3rd Calciferous limestone (upper part)
1905	Bain and Ulrich (a, b)	Jefferson City limestone (middle part)
	Adams and Ulrich	Yellville formation (upper part)
1915	**Ulrich (*in* Ulrich and Bassler)**	**Powell limestone (first description**; unpublished manuscript)
1916	**Ulrich (*in* Purdue and Miser)**	**Powell limestone (first published description)**
1918	Branson	Jefferson City formation (upper part)
1921	Dake	Powell limestone of Jefferson City group
1924	Krey	Jefferson City group (upper part; "= Winfield limestone of Keyes")
1944	Branson	Cotter formation (upper part)
1950	Bretz	Powell member of Jefferson City formation
1961	Martin et al. (a)	Powell formation
1977	Thacker and Satterfield	Powell Dolomite (southeastern Missouri)
1982	Thompson	Powell Dolomite
1991	**Thompson (present report)**	**Powell Dolomite**

Remarks -- At the suggestion of E.O. Ulrich, Purdue and Miser (1916, p. 5), first described the Powell Dolomite. They stated,

> "The term Yellville, as has been stated under the heading 'Cotter dolomite,' was applied in 1904 and again in 1905 by G. I. Adams and E.O. Ulrich to strata that have since been divided into what are herein called Cotter dolomite below and Powell limestone above; and Ulrich, in 1911, restricted the name Yellville to the upper of the two."

Martin et al. (1961a, p. 24) stated that in Missouri

> "The Powell formation is composed primarily of medium to finely crystalline dolomite and thin beds of green shale and fine-grained sandstone."

In Ste. Genevieve County, Weller and St. Clair (1928, p. 86) divided the Powell into lower and upper parts, the lower part containing several typically dark-brown sandstone beds, and the upper part composed of finely crystalline argillaceous dolomite ("cotton rock") and thin beds of green shale. Soft ferruginous and "rotten" chert characterizes the residues of the Powell Dolomite in its areas of outcrop.

As described under "Cotter Dolomite," the Cotter-Powell contact has been defined as unconformable, representing a pre-Powell erosion surface in eastern Missouri (Weller and St. Clair, 1928) and northwestern Arkansas (Purdue and Miser, 1916). Some question still exists concerning how much, if any, Powell is actually present in southwestern Missouri. A characteristic drusy chert zone used to identify basal Powell in northern Arkansas (the **"Black Ledge"**) has not been identified in Missouri; thus, some areas identified as Powell may correlate with upper Cotter in Arkansas. In eastern Missouri the Powell is identified primarily by residue zones, but it may not correlate exactly with the Powell of Arkansas.

Powell strata are the youngest Ordovician rocks in southwestern Missouri, but in parts of southeastern and east-central Missouri (fig. 31) and in the subsurface of north-central Missouri they are overlain by the Smithville Dolomite or by "Middle" (Whiterockian and Mohawkian) and Late Ordovician rocks.

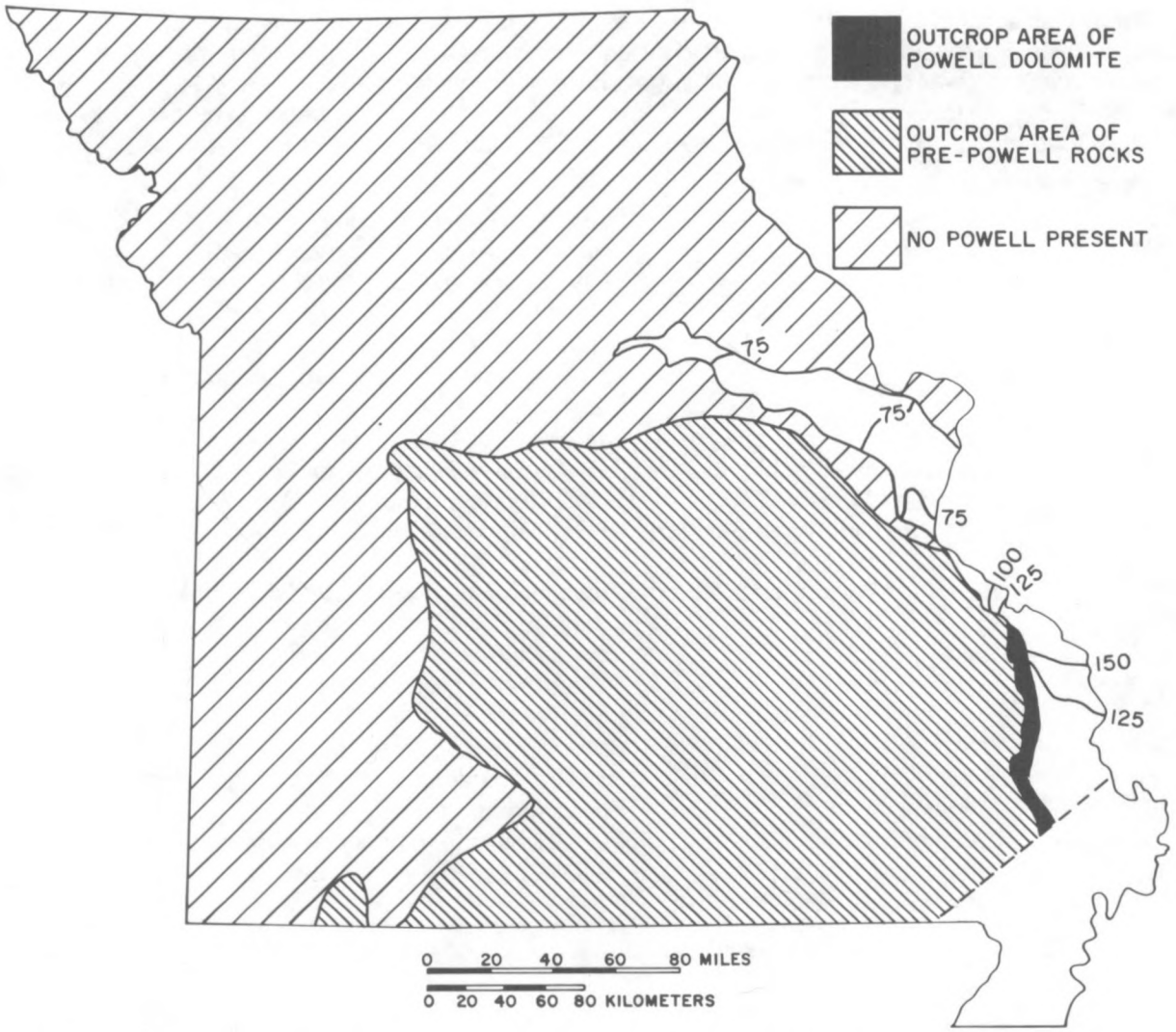


Figure 31. *Isopach map, distribution, and areas of outcrop of rocks identified as* **Powell Dolomite** *in Missouri. Isopach interval is 25 ft.*

Fossils are rare in the Powell, except in the drusy quartz zone (the "Black Ledge") discussed above. In northwestern Arkansas cephalopods and gastropods are common in this thin zone.

Martin et al. (1961a, p. 24) stated,

> "The Powell crops out in eastern Missouri, from Cape Girardeau County northward to Ste. Genevieve County and is also present in extreme southwestern Missouri. It is present in the subsurface except in the west-central and northwestern parts of the state. Its thickness in Ste. Genevieve County ranges from 150 to 175 feet."

Smithville Dolomite

Branner, 1929

Original description -- Branner proposed the "Smithville formation" as a formal unit, without descriptions, on the *Geologic Map of Arkansas* (1929).

Type section -- The formation was first mapped in and around Smithville, Lawrence County, Arkansas, sec. 27 or 28, T. 17 N., R. 3 W., Smithville 7½' Quadrangle.

Reference sections -- In Missouri, the Smithville Dolomite is exposed only in southeastern counties: in the northern parts of Crowleys Ridge in the "Bootheel" region of the Mississippi River Valley, and in a few roadcuts on I-55 in Perry and Ste. Genevieve counties. The basal 3 to 4 ft of the Smithville Dolomite was identified by Thacker and Satterfield (1977) in a roadcut on I-55 in Ste. Genevieve County (fig. 30).

History of nomenclature

1905	Bain and Ulrich	Jefferson City limestone (upper part)
1911	Ulrich (b)	Yellville group (upper part)
1915	Ulrich (*in* Ulrich and Bassler)	Cotter formation (part; unpublished manuscript)
1929	**Branner**	**Smithville formation (no description)**
1931	McQueen (b)	Smithville-Black Rock formations (lower part)
1961	Martin et al. (a)	Smithville formation
1986	Stinchcomb	Smithville Formation
1991	**Thompson (present report)**	**Smithville Dolomite**

Remarks -- Ulrich (1911b) described sections of his "Yellville group" of the Canadian Series, in the vicinity of Smithville, northeastern Arkansas. Branner proposed the Black Rock and Smithville as separate formations on the *Geologic Map of Arkansas* (1929); this constituted the first publication of the name as a formal stratigraphic unit. Hedden (1976) proposed a regional depositional cross-section correlating the Powell, Smithville, and Black Rock as depositional facies of a single episode: the Black Rock, a basinal, more normal marine facies; the Smithville, a marginal marine facies; and the Powell, a shelf or tidal facies.

As described by Martin et al. (1961a, p. 24), in Missouri the Smithville is a dolomite containing small quantities of chert, the amounts being generally less than that of the underlying Powell Dolomite. Outcrops are restricted to southeastern Missouri from northern Scott to northern Perry counties. In southeastern Missouri, gastropods regarded as diagnostic of the Smithville occur in residual chert in Bollinger County and in a quarry near Delta, in Cape Girardeau County. Fresh exposures do not yield fossils, but weathered exposures often do. The formation is present in the subsurface south and east of Cape Girardeau (fig. 32), and may be as much as 150 ft thick. Because the Smithville is lithologically similar to and conformable with the underlying Powell Dolomite, it is most often distinguished from the Powell by insoluble residues. The uppermost Canadian formation in Missouri, the Smithville Dolomite is disconformably overlain by rocks ranging in age from the "Middle Ordovician" Everton Formation (Whiterockian Series) to Cretaceous-Tertiary formations in the "Bootheel" region.

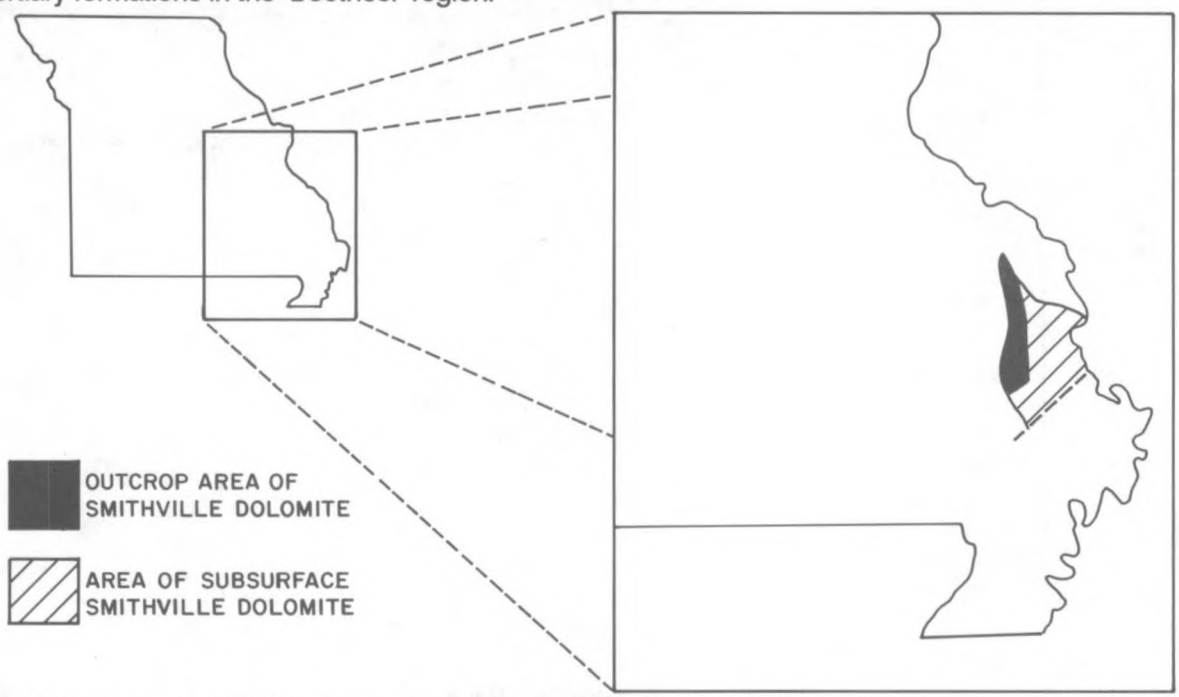


Figure 32. *Presumed distribution map of the* **Smithville Dolomite** *in Missouri.*

"MIDDLE ORDOVICIAN"

Type localities -- The traditional "Middle Ordovician" series and stages for North America (fig. 1) were named from sections in New York and surrounding states, but several units, e.g., Whiterockian, have been described from exposures in Nevada, where some "Middle Ordovician" rocks are more completely preserved and exposed than in eastern North America.

History of nomenclature

1866	Worthen	Cincinnati group (lower part; Kimmswick)
		Trenton group (Joachim-Kimmswick)
1899	Clark and Schuchert	Mohawkian
1909	Savage	Mohawkian series (lower part; Kimmswick)
1911	Ulrich (b)	Lowville group (lower Black River)
		Onondaga (?)
	Vaughn	Black River group
1914	Schuchert and Barrell	Champlainian series (includes Chazyan strata; Mohawkian does not)
	Keyes	Mohawkian series
		Minnesotan series (between Canadian and Mohawkian series)
1915	Ulrich and Bassler	Big Buffalo series (in Arkansas)
	Keyes	Mohawkian series
		Minnesotan series (between Canadian and Mohawkian series)
1922	Buehler	Buffalo group (Everton-Joachim)
1923	Bridge and Ingerson	Middle Ordovician
1926	Ulrich	Chazyan series
		Buffalo River series
1927	Edson	Trenton (Kimmswick)
		Black River (Lowville; Decorah-Plattin)
		upper Chazy (Blount; St. Peter-Joachim)
		lower Chazy (Stones River; Everton)
1928	Folger	Mohawkian group (Plattin-Kimmswick)
		Chazyan group (St. Peter-Joachim)
1929	Kay (a)	Mohawkian series (Kimmswick)
	Edson	Trentonian (Kimmswick)
		Mohawkian (Plattin-Decorah)
		Chazyan (Everton-Joachim)
	Kay (b)	Mohawkian
		Trenton (Kimmswick)
		Black River (Plattin-Decorah)
		Chazyan (St. Peter-Joachim)
1933	Branson and Mehl (a, b)	Middle Ordovician
1937	Keyes (a)	Mohawkian series
	McQueen	Black River group
	Grohskopf and Hundhausen	Ordovician series (of Ulrich)
	Thiel	Trenton
		Black River (upper Joachim-Plattin)
		Chazyan (St. Peter-lower Joachim)
1939	Ulrich	Black River series (Plattin)
		Chazyan series

		Buffalo River series (Everton-Joachim)
	Grohskopf et al.	Mohawkian series (Plattin-Kimmswick)
		Big Buffalo series (Everton-Joachim)
1941	Keyes	Mohawkian series
		Minnesotan series (St. Peter)
1944	Branson	middle Ordovician
1945	Greene	Ordovician or Canadian system ("Arbuckle")
1951	Larson	Middle Ordovician
1954	Twenhofel et al.	Champlainian series
1961	**Martin et al. (a)**	**Champlainian Series**
		Mohawkian Stage
		Chazyan Stage
1963	Templeton and Willman	Champlainian Series
		Mohawkian Stage (Plattin-Kimmswick)
		Chazyan Stage (Everton-Joachim)
1970	Kay	Chazyan Series
1971	Sweet and Bergström	Shermanian Stage (replaced "Trenton")
1973	Barns et al.	Champlainian Series
		Trentonian Stage
		Blackriveran Stage
		Chazyan Stage
		Whiterockian Stage
1977	Thacker and Satterfield	Champlainian Series
1982	**Ross et al.**	**Mohawkian Series (St. Peter-Kimmswick)**
		Whiterockian Series (Everton)
1984	Klapper and Bergström	Middle Ordovician (Champlainian-Whiterockian)
1991	**Thompson (present study)**	**Mohawkian Series**
		Whiterockian Series

Remarks -- Templeton and Willman (1963) had the choice of using "Champlainian" or "Mohawkian" and "Chazyan" for "Middle Ordovician" rocks in the Illinois Basin. They stated (p. 26),

> "The terms Champlainian (Schuchert and Barrell, 1914, p. 16, 25) and Mohawkian (Clarke and Schuchert, 1899, p. 876-877) are both in current use as names for the middle series of Ordovician rocks. The choice of names depends largely on the age assignment of the Chazy Group in New York. The Mohawkian type area does not include the Chazy Group, and the name Mohawkian originally included only Black River and Trenton strata. We prefer the term Champlainian because it does include the Chazy Group."

Champlainian strata consisted of the Chazyan and Mohawkian Stages; the latter was divided into the Blackriveran and overlying Trentonian "Substages" (fig. 1). Ross et al. (1982) reclassified "Middle Ordovician" into two series: the lower **Whiterockian Series**, which included the Chazyan Stage, and the upper **Mohawkian Series**. This classification best reflects current understanding of the relationships of the Ordovician series as redefined from the Cincinnati region in the past 10 years (fig. 2).

In Missouri, "Middle Ordovician" rocks (formerly referred to the Champlainian Series by Martin et al., 1961a) crop out in a belt surrounding "Lower Ordovician" (Canadian Series) and Upper Cambrian strata on the northern, northeastern, eastern, and southeastern flanks of the Ozark Uplift (figs. 33 and 34); they are absent on the western and southwestern flanks. Martin et al. (1961a, p. 24-25) stated,

> "In southeastern Missouri, rocks of the Champlainian Series crop out in a continuous belt 2 to 20 miles wide that extends from northeastern Scott County northwestward through Cape Girardeau, Perry, Ste. Genevieve, and Jefferson Counties to Franklin and St. Louis Counties. North of the Missouri River, an outcrop belt of middle Ordovician rocks roughly parallels the river in St. Charles, Warren, Montgomery, and eastern Callaway Counties. In Lincoln, Ralls, and Pike Counties, in northeastern Missouri, rocks belonging to the Series are present at the surface along the Lincoln fold. The outcrop belt of Champlainian rocks in this area extends northwestward from Winfield in Lincoln County to the vicinity of Spalding in Ralls County, along the north flank of the fold. Outliers of middle Ordovician rocks crop out in Callaway, Cooper, Boone, and Saline Counties. In the subsurface, formations of the Series are recognized from nearly all counties north of the

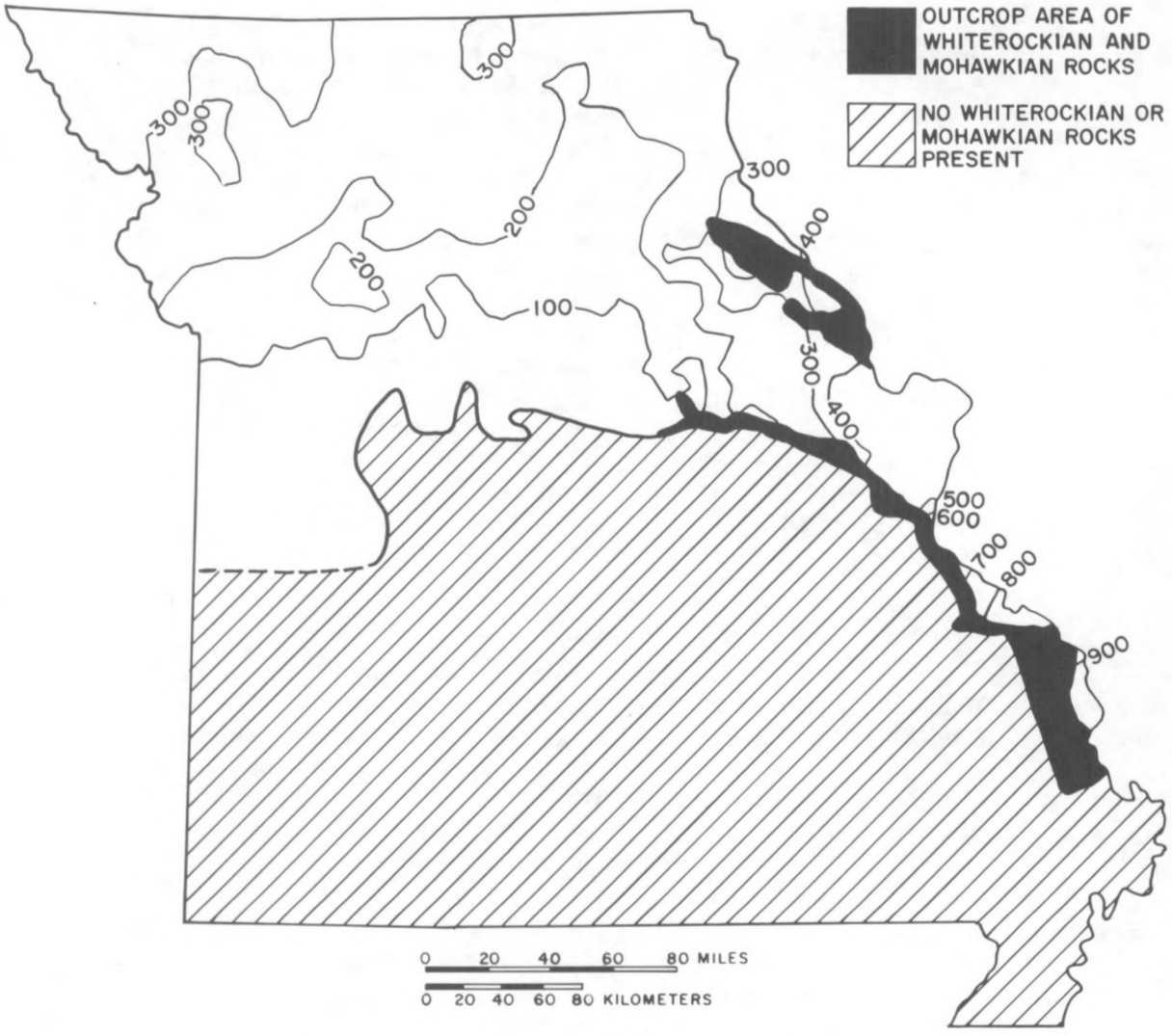


Figure 33. *Isopach map, distribution, and areas of outcrop of rocks of the* **Whiterockian** *and* **Mohawkian Series** *in Missouri. Isopach interval is 100 ft.*

Missouri River. South of the Missouri River, they are present in the subsurface east of the outcrop belt where they dip beneath younger strata into the Illinois basin. In western Missouri, middle and upper Ordovician strata have been removed by pre-Mississippian post-Canadian erosion."

At the time the present report was written, the terms "Lower," "Middle," and "Upper" Ordovician were being avoided by many Ordovician stratigraphers (D. Kolata, Illinois Geological Survey, personal communication, 1986) as ambiguous. A four-part series division is now used. Consensus is to use the formal series and stage names, without reference to "lower," "middle," or "upper." Therefore, if used in this report, it will be written "Middle Ordovician."

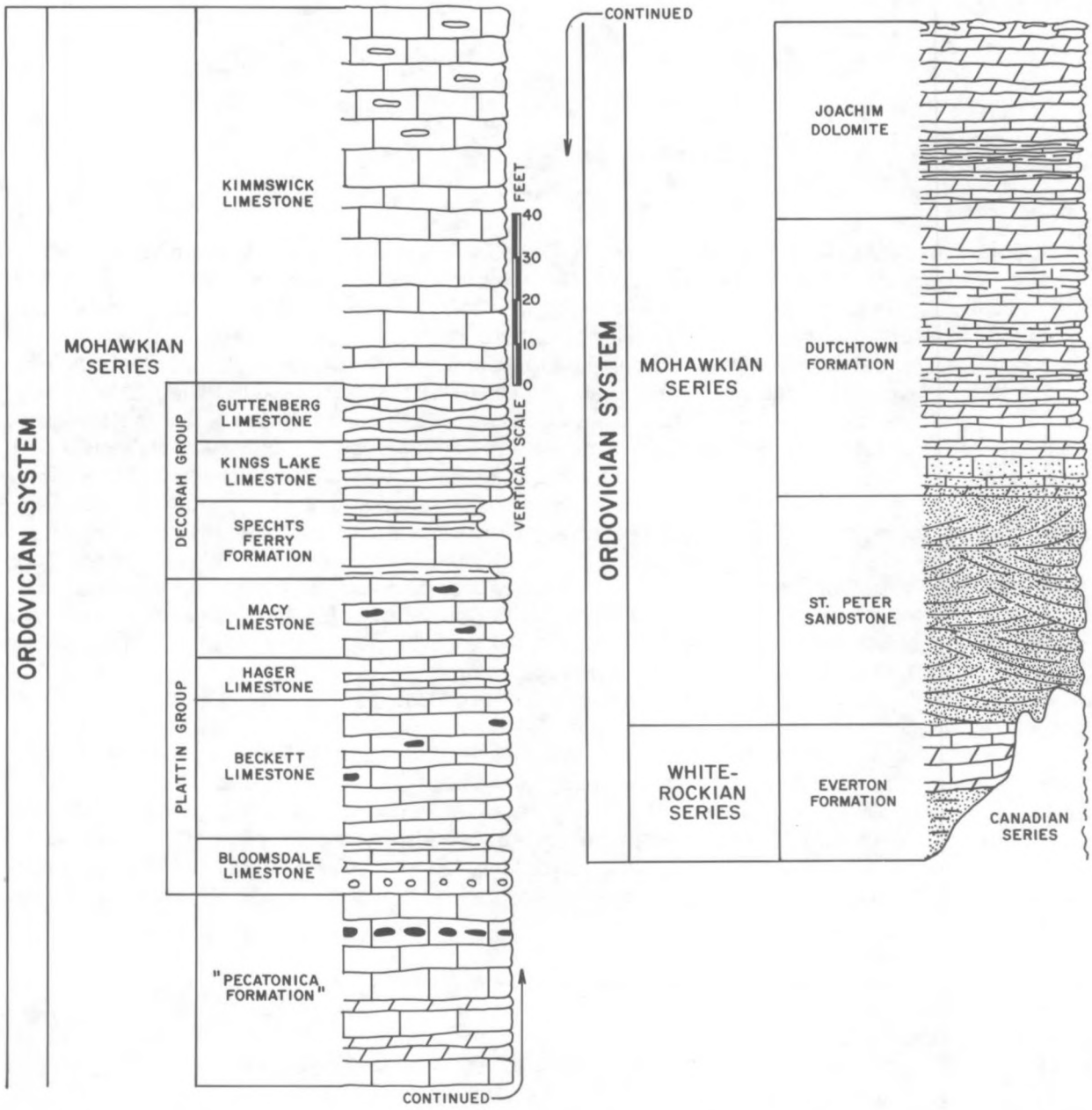


Figure 34. *Generalized columnar section of formations of the* **Whiterockian** *and* **Mohawkian Series** *in Missouri.*

WHITEROCKIAN SERIES

Cooper, 1956

Original description -- (Cooper, 1956, p. 7-8) "Whiterock Stage. -- This name is taken from Whiterock Canyon in the Monitor Range in the south center of the Roberts Mountain Quadrangle, Nev. The rocks of the interval are well exposed in parts of the Antelope, Monitor, and Toquima Ranges shown on the same sheet. The brachiopod fauna taken from rocks deposited during this stage is characterized by numerous orthids, the early strophomenids, plectambonitids, and the decline of the Syntrophiacea. Correlative rocks appear in the Arbuckle Mountains of Oklahoma and the Table Head series of Newfoundland. Exotic blocks containing fossils related to the Table Head of Newfoundland have been found in the boulders of the Mystic conglomerate and from a little known formation near North Cambridge, N.Y. Equivalents of these beds in Europe are not clearly understood, but some related forms have been taken in Norway and Estonia."

Ross, *in* Ross et al. (1982, p. 12) defined the Whiterockian Series as follows:

"The base of the Whiterock Series is established at the lowest occurrence of the fossils indicative of Zone "L" of Ross (1951, 1970) and of Hintze (1952), particularly the brachiopod *Orthidiella*, in the transition between the Ninemile Formation and the Antelope Valley Limestone on the west side of a tributary gully on the north side of Whiterock Canyon in the SW¼, SW¼, Sec. 34, T. 49 E., R. 16 W., Horse Heaven Mtn. 15' Quadrangle, Nev. At this locality, as at Meiklejohn Peak and at the Ranger Mts. to the south, *Orthidiella* is accompanied by *Ingria cloudi* in the upper part of its range.

"The trilobite genus *Ectenonotus* has been considered by Ross (1970, p. 28, 45-47) to be so closely associated with *Orthidiella* that it was used to indicate the lower part of the zone where *Orthidiella*, itself, was absent. That correlation has been questioned by Hintze, above, and by Ethington and Clarke (1982) on the grounds that *Ectenonotus* occurs stratigraphically below *Orthidiella* at Ibex, Utah. In fact, that stratigraphic relationship also holds at Meiklejohn Peak. At Rawhide Mountain their ranges overlap, however. *Ectenonotus* has been used over a large part of the world to indicate the presence of Whiterockian strata. Because the trilobite and the brachiopod are usually found in quite different lithologies in Nevada localities, the possibility of facies rather than temporal control must be considered before a hasty decision is made."

Type locality -- Whiterock Canyon in the Monitor Range, Nevada.

History of nomenclature

1961	Martin et al. (a)	Champlainian Series (lower part) Chazyan Stage (lower part)
1982	**Ross et al.**	**Whiterockian Series**
1984	Klapper and Bergström	Whiterockian Series
1991	**Thompson (present report)**	**Whiterockian Series**

Remarks -- Proposed to include rocks in Nevada that did not fit into the classical divisions of the Ordovician System, the Whiterockian Series includes, in the upper portion, strata previously assigned to the **Chazyan Stage** of the Champlainian Series, and a sequence beneath typical, but post-Canadian, Chazyan rocks. In Missouri, the only formation of Whiterockian age is the **Everton Formation**, which rests disconformably on rocks of the Canadian Series. The Whiterockian-Mohawkian boundary, represented by the Everton - St. Peter contact in eastern Missouri, is also disconformable, whereas elsewhere in Missouri the St. Peter lies on Canadian strata, Whiterockian strata being missing.

Martin et al. (1961a, p. 24) included the Everton, St. Peter, Dutchtown, and Joachim in the Chazyan Stage, whereas now only the Everton is considered Chazyan. The St. Peter, Dutchtown, and Joachim are assigned to the Blackriveran (or Black Riveran) Stage of the Mohawkian Series.

Everton Formation

Ulrich, *in* Purdue, 1907

Original description -- (Purdue, 1907, p. 251-252) "Near the Arkansas-Missouri line the Ordovician rocks exposed along the sides of the rather deep ravines consist of manganesian limestone containing several beds that are more or less cherty and locally thin beds of ripple-marked sandstone. A few miles south of the Arkansas-Missouri line there appear at the top of the manganesian limestone two beds of sandstone with an intervening bed of limestone. These sandstones are (at least tentatively) regarded by Mr. E. O. Ulrich, of the U.S. Geological Survey, as the Lower and Upper Saint Peter, and he named the limestone Everton, from the town of Everton, Boone county, Arkansas..."

"The Everton limestone overlaps the Lower Saint Peter to the north and is (at least locally) unconformable on the rocks below. At the top of the Everton limestone there is a pronounced unconformity, which is strikingly visible at all points where this formation outcrops on the hillsides."

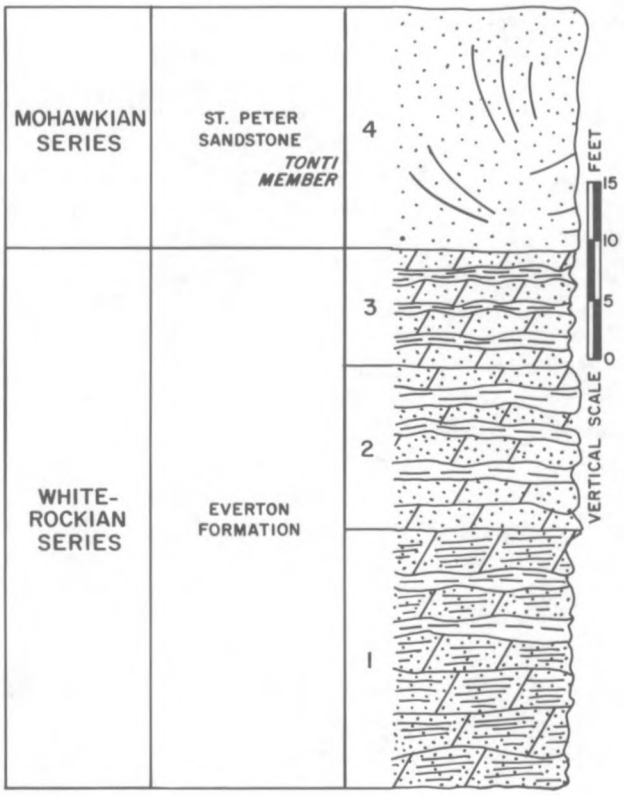
Purdue and Miser (1916, p. 5) first described the Everton: "The Everton limestone was named by E.O. Ulrich from Everton Ark., where it is well developed. It consists of three subdivisions... (1) at the base a sandy magnesian limestone, called the Sneeds limestone lentil, from Sneeds Creek, southwest of Compton, in the Harrison quadrangle, where it is typically developed; (2) a massive saccharoidal sandstone, called the Kings River sandstone member, from Kings River, in the Eureka Springs quadrangle, where it is best developed; and (3) a fine-grained nonmagnesian limestone interbedded with sandstone, which forms the bulk of the formation..."

Type section -- Purdue and Miser (1916, p. 5) stated that all parts of the Everton Formation "... are well exposed on Sneeds Creek [secs. 8 and 9, T. 16 N., R. 22 W., Newton Co., Arkansas, Ponca 7½' Quadrangle] and in Hemmed-in-Hollow, about 2 mi south of Compton..." A single type section has not been defined for the Everton.

Reference sections -- The Everton Formation is exposed in several roadcuts on I-55, in Ste. Genevieve County, southeastern Missouri. One of them (fig. 35) is in the SW¼ NW¼ sec. 11, T. 38 N., R. 7 E., Bloomsdale 7½' Quadrangle, where the upper part is well exposed. Lower and upper Everton are exposed about 0.25 to 0.75 mi southeast of the bridge over Establishment Creek, NE¼ SE¼ sec. 24 (projected), T. 39 N., R. 7 E., Weingarten 7½' Quadrangle (fig. 36). Upper Everton strata are well exposed between mile posts 171 and 172 on I-55, NE¼ NE¼ SW¼ sec 28, T. 40 N., R. 6 E., Jefferson County, Selma 7½' Quadrangle (fig. 37).

History of nomenclature

1855	Swallow	Saccharoidal Sandstone (lower part; southeastern Missouri)
1873	Pumpelly	Saccharoidal sandstone (lower part)
1894	Winslow	Crystal City sandstone (lower part; southeastern Missouri)
1898	Keyes	Saccharoidal or Roubidoux sandstone (lower part)
	Shepard	1st sandstone (lower part)
1900	Gallaher	St. Peter sandstone (lower part)
1904	Buckley and Buehler	St. Peter or Pacific sandstone (lower part)
	Broadhead	Saccharoidal sandstone (lower part)
1907	**Ulrich (*in* Purdue)**	**Everton limestone**
1908	Buckley	St. Peter sandstone (lower part)
1911	Ulrich	Everton formation
1915	Ulrich and Bassler	Everton limestone (unpublished manuscript) Sneeds limestone
1916	Purdue and Miser	Everton formation Kings River sandstone member Sneeds limestone lentil
1918	Branson	St. Peter formation (lower part)



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

St. Peter Sandstone

Tonti Member

4. Sandstone, fine- to medium-grained, rounded and frosted, poorly cemented, massively bedded; "pipe structures" developed on some weathered surfaces. (20-22 ft)

WHITEROCKIAN SERIES

Everton Formation

3. Shale, green, interbedded with finely crystalline dolomite; dolomite has abundant floating quartz grains and stringers of fine-grained sandstone; beds undulating; contact with overlying St. Peter Sandstone approximately 3 ft above bench. (8-10 ft)
2. Dolomite, dark-brown, finely crystalline, weathers blue-gray; thin to massive undulating beds separated by green shale beds up to 4 in. thick; floating sand grains throughout dolomite. (13-14 ft)
1. Sandstone and sandy dolomite, fine- to medium-grained, massive wavy beds separated by green shale beds up to 4 in. thick; quartz grains rounded and frosted; dolomite beds appear thinly laminated due to abundant planar stromatolites; thin dark-brown dolomite beds near top of unit. (21 ft 6 in.)

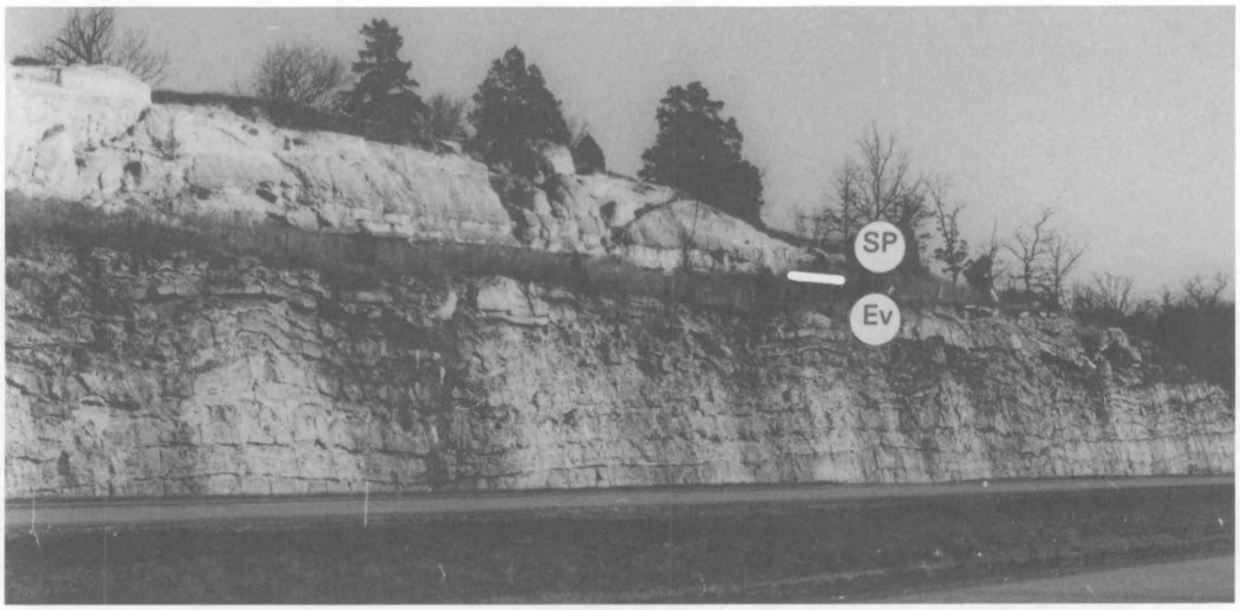
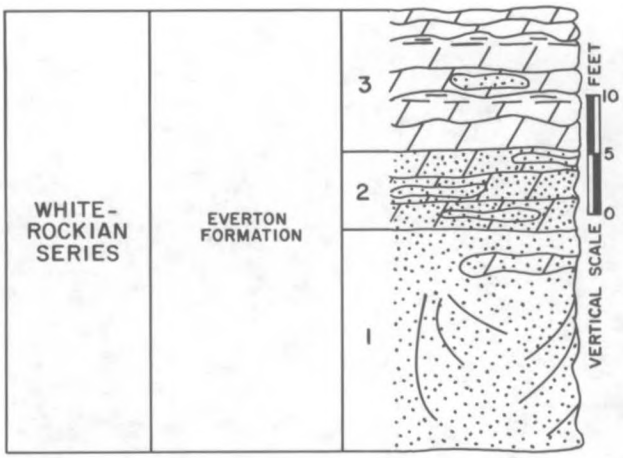


Figure 35. *Exposure of the* **Everton Formation (Ev)** *and lower part of the* **St. Peter Sandstone (SP)** *in a roadcut on I-55, SW¼ NW¼ sec. 11, T. 38 N., R. 7 E., Ste. Genevieve County, southeastern Missouri, Bloomsdale 7½' Quadrangle. Adapted from a description by Thacker and Satterfield (1977). Photograph by T.L. Thompson.*



ORDOVICIAN SYSTEM - WHITEROCKIAN SERIES
Everton Formation

3. Dolomite, chocolate-brown, finely crystalline; weathers to buff; thin to massive highly undulating beds separated by green shale beds 1-3 in. thick, beds become thinner toward top; sandstone stringers prevalent in upper 5 ft of cut; some conglomerate. (10-12 ft)
2. Dolomite, light-brown to light-gray, finely crystalline, very argillaceous; weathers buff; massive bedding; sand stringers up to 10 in. thick common. This may represent a lower-upper Everton transition. (5 ft)
1. Sandstone, fine- to medium-grained, poorly cemented; grains rounded and frosted; thin to massive beds; lenses of dolomite containing floating sand grains in upper 4 ft. (18 ft)

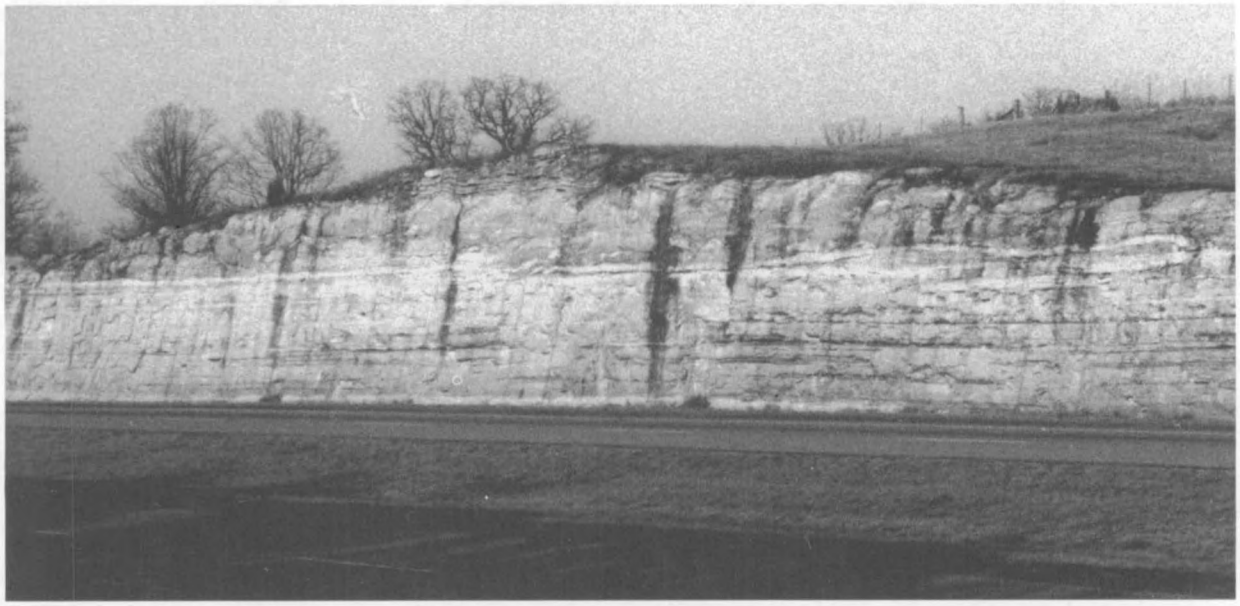


Figure 36. *Exposure of the* **Everton Formation** *in a roadcut on I-55, NE¼ SE¼ sec. 24 (projected), T. 39 N., R. 7 E., Ste. Genevieve County, southeastern Missouri, Weingarten 7½' Quadrangle, mileage 155.9. Adapted from a description by Thacker and Satterfield (1977). Photograph by T.L. Thompson.*

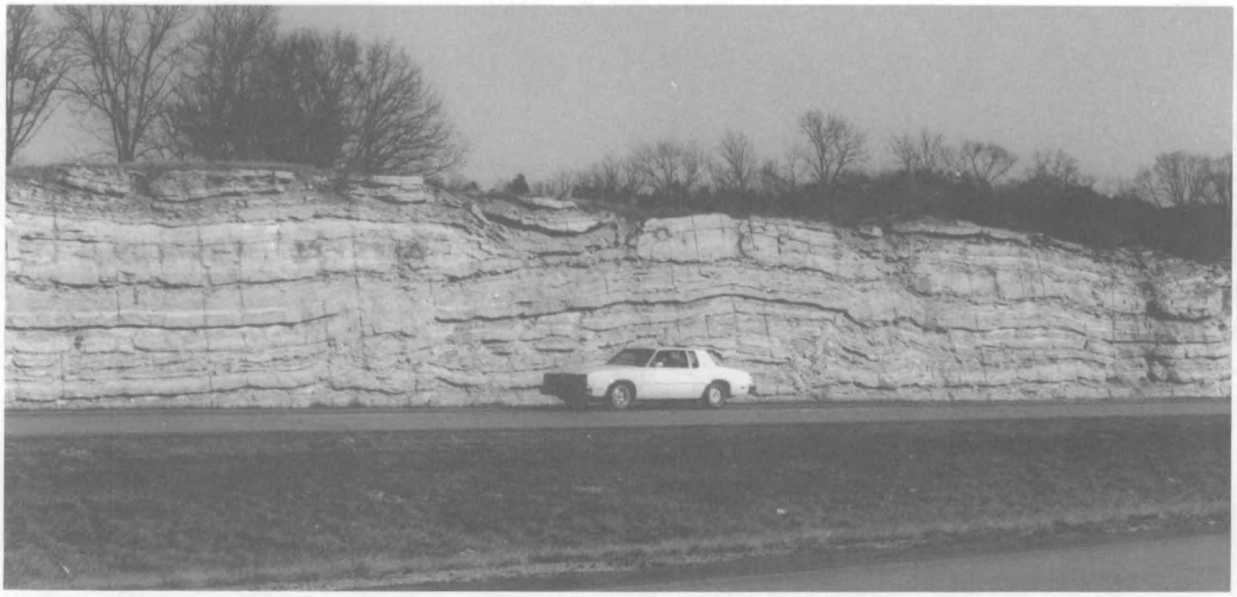


Figure 37. *Upper part of the* **Everton Formation** *exposed in a roadcut on I-55, between mile posts 171 and 172, NE¼ NE¼ SW¼ sec. 28, T. 40 N., R. 6 E., Jefferson County, southeastern Missouri, Selma 7½' Quadrangle. Photograph by T. L. Thompson.*

1921	Dake	Everton formation of St. Peter group
1928	Weller and St. Clair	Everton formation Kings River sandstone member
1939	Ulrich	Everton Newton or Calico (both called part of "St. Peter")
1944	Branson	Everton formation
1961	Martin et al. (a)	Everton formation
1963	Templeton and Willman	Everton Group Jasper Limestone (in Arkansas)
1982	Thompson	Everton Dolomite
1986	Sargent and Norby	Everton Dolomite
1991	**Thompson (present report)**	**Everton Formation**

Remarks -- In Missouri the Everton Formation consists mostly of sandy dolomite in the upper part and massive sandstone in the lower part, but it also contains interbedded sandstone, limestone, and chert. The dolomite is both light and dark gray and commonly contains scattered quartz sand grains. The sandstone is fine to very fine grained and is silty in many places; the sand grains are rounded and commonly pitted or frosted. The massive sandstone of the lower part of the Everton may resemble the sandstone of the overlying St. Peter, but average grain size in the Everton is generally smaller. Where the two sandstones are in contact, they cannot always be readily distinguished. White to medium-gray chert in thin beds, lenses, and nodules is sporadically distributed throughout most of the formation.

In Missouri the Everton is dominantly a dolomite or a dolomitic sandstone, and sandstone. The dolomite is typically finely crystalline, and bedding is flaggy or slabby. Approximately two-thirds of the dolomite is gray or some shade of gray; the rest is brown. Twenty-five to 40 percent of the unit is sandstone; a few shale seams or bands occur locally. The shale is slightly conglomeratic, locally quartzitic, and contains only a trace of chert.

In Ste. Genevieve and southern Jefferson counties the Everton can be divided into two lithologic units previously recognized by Weller and St. Clair (1928, p. 91). The lower is a sandstone, 35 to 80 ft thick; the upper, a sandy dolomite, 45 to 65 ft thick.

Templeton and Willman (1963, p. 28) stated,

> "Distribution. -- Everton strata crop out around the flanks of the Ozark Dome in northern Arkansas and eastern Missouri, but are overlapped by younger formations around the remainder of the dome. They thin rapidly northward and eastward, and are missing beyond Knox County, northeastern Missouri (Grohskopf, et al., 1939, p. 58-59) and St. Clair County, southwestern Illinois.
>
> "Thickness. -- The group is over 500 ft thick in southeastern Missouri (McQueen, 1939, p. 67), more than 475 ft thick in a well at Cape Girardeau, Missouri (McQueen, 1937, p. 9), and from 100 to 125 ft thick in wells in Monroe County, Illinois."

McQueen (1937), however, may have included the Starved Rock Member of the St. Peter Sandstone in the Everton, thus exaggerating the thickness of the Everton, particularly in southeastern Missouri. Outcrops of the Everton Formation are restricted to east-central and southeastern Missouri, from northern Scott County, through Cape Girardeau, Perry, and Ste. Genevieve counties, to the northwestern corner of Jefferson County (fig. 38). Thickness is from 5 ft to as much as 140 ft in the area of outcrop; the formation is thickest in Ste. Genevieve County. North of Jefferson County the Everton is completely eroded or was never deposited because of pre-Everton structure. The uneven thickness of the Everton over short lateral distances is due to the prominent relief on the Canadian surface on which the Everton was deposited, and to partial removal by pre-St. Peter erosion. This "pinching-out" of the Everton can readily be seen in roadcuts

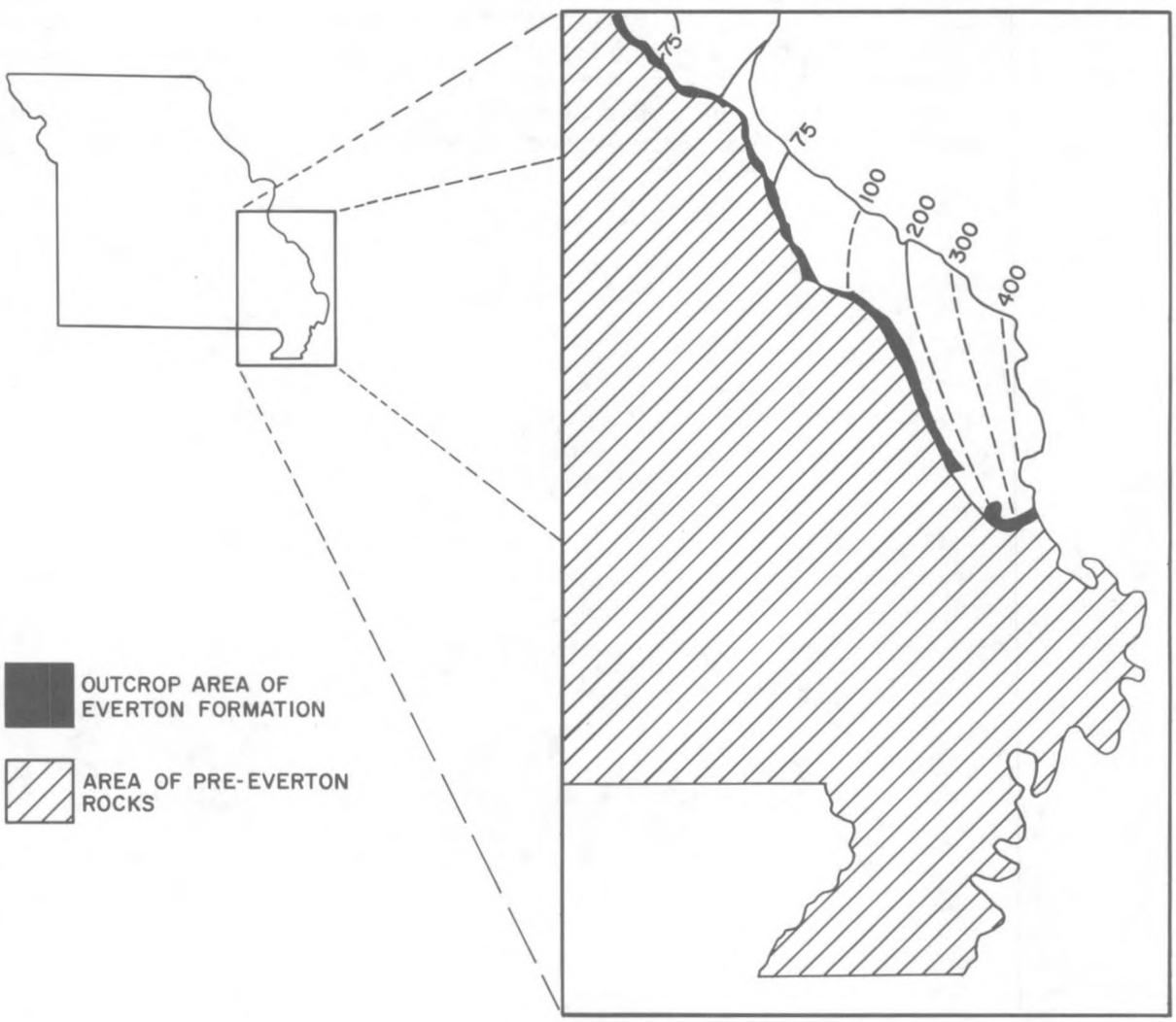


Figure 38. *Isopach map, distibution, and areas of outcrop of the* **Everton Formation** *in Missouri where both the lower sandstone and upper carbonate beds are present.*

on Jefferson County road A between Missouri Highway 21 and I-55. Both upper and lower Everton are present at the eastern end of Highway A, but westward in a series of roadcuts the lower Everton sandstone thins and disappears followed by thinning and final disappearance of the upper carbonate.

In the subsurface the Everton Formation has been identified in north-central Missouri, in Boone, Callaway, Montgomery, and Audrain counties, where it is 10 to 85 ft thick. In northeastern Missouri, it is locally present in Monroe and Ralls counties. In the subsurface the Everton consists mainly of dolomite, sandy dolomite, sandstone, and calcareous sandstone; limestone, shale, and chert are present in smaller amounts. The dolomite is dense, light to medium gray and grayish to light brown, and sublithographic to finely crystalline. The light-gray, fine-grained dolomite usually shows the greatest variation in amount of included sand. Dolomite in the Everton closely resembles the Joachim Dolomite in east-central Missouri. The limestone is dense, light to medium brown or light gray, sublithographic, and may contain large ostracods, oolites, and/or relict oolites. Shale, when present, is either medium green or light gray and may contain quartz grains. Chert is rare, but when present, is white and rough. Sandstones are "St. Peter-like," except that dolomitic cement is more common in sandstone in the Everton than in the St. Peter.

The Everton lies with conspicuous unconformity on Canadian strata that include Cotter Dolomite in the subsurface of central Missouri, and the Cotter, Powell, or Smithville Dolomite in eastern and southeastern Missouri. The upper contact of the Everton is also unconformable. In the subsurface the formation may be overlain by St. Peter Sandstone or by Devonian or Mississippian strata.

Sweet and Bergström (1976, p. 147) stated that the conodont form-genera *Multioistodus* and *Histiodella*, recovered by Golden (1969) from Everton strata in southern Missouri and northern Arkansas, placed the Everton in the Whiterockian Stage, which Sweet and Bergström (1976, text-fig. 2) indicated as the interval of their faunas 2-4. Some of the upper limy dolomite beds contain poorly preserved fossils. Beds of dolomitic algal material are exposed in roadcuts on I-55, in Ste. Genevieve County, southeastern Missouri (figs. 35 and 37).

MOHAWKIAN SERIES

Clarke and Schuchert, 1899

Original description -- (Bergström, *in* Ross et al., 1982, p. 12) "Mohawkian is an appropriate term for the post-Whiterockian, pre-Cincinnatian interval in the standard time-stratigraphic classification of the Ordovician of the United States. The general reference area is in the Black River and Mohawk valleys of New York, and supplementary sections are present in adjacent parts of Ontario. However, for reasons already stated we propose that the stratotype for the base of the MOHAWKIAN SERIES be at the base of or very low in the Elway Formation in the stratigraphic section near the Lay School in the Hogskin Valley, Tennessee; the base of the Series is taken as the base of the Subzone of *Prioniodus (B.) gerdae* (conodont), a level that closely approximates the bottom of the typical Ashby Stage of Cooper (1956, p. 8). We propose that the top of the Mohawkian be defined as the base of the Cincinnatian Series."

Remarks -- According to Ross et al. (1982), the upper part of the "Middle Ordovician" (figs. 1 and 39A), the **Mohawkian Series**, consists of the following stages:

Shermanian Stage (middle Kimmswick Limestone; "Wise Lake Formation")
Kirkfieldian Stage (basal Kimmswick Limestone; "Dunleith Formation")
Rocklandian Stage (Decorah Group)
Black Riveran Stage (St. Peter Sandstone, Joachim Dolomite, "Pecatonica Formation, " and Plattin Limestone)

Sweet and Bergström (1976, p. 133) included the Prosser, Stewartville, and Dubuque of Iowa and Minnesota (upper Dunleith, Wise Lake, and Dubuque), and approximately the upper half of the Kimmswick Limestone of Missouri in the overlying Cincinnatian Series (fig. 39B).

The Rocklandian, Kirkfieldian, and Shermanian Stages constitute what was previously the lower part of the Trentonian Stage, the upper part of which is now equivalent to the Edenian Stage of the Cincinnatian Series.

"*Ancell Group*"

Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 31) "Ancell strata are considered a group for the following reasons.

1) The sequence consists of sandstones and impure dolomites and limestones, most of which wedge out in various directions and consequently are irregularly distributed.

2) The sequence differs in many lithologic details from the underlying Everton Group and contrasts sharply with the overlying less clastic, much more continuous strata of the Platteville Group.

3) The Ancell Group is bound by unconformities or diastems.

4) Strata of Ancell lithology are present throughout much of the eastern United States."

Type section -- Templeton and Willman (1963, p. 29) stated, "The Ancell Group is named for the village of Ancell, Scott County, southeastern Missouri, near which its contacts with the Everton Group below and the Platteville Group above are well exposed. The type exposures are (1) in the north bluff of the lowland southwest of Cape Girardeau, between Everton outcrops 2 miles west of Dutchtown and Pecatonica outcrops at Rock Levee (Cape Girardeau Quad.), and (2) in the south bluff of the same lowland between Ancell and Rockview (Morley Quad.)."

Remarks -- The Ancell Group is a succession of strata related by facies (fig. 40), and separated by distinct to inferred diastems or unconformities from the overlying strata (Plattin Group) and the underlying Everton Formation. The Dutchtown Formation and Joachim Dolomite are offshore facies of the Starved Rock Member of the St. Peter Sandstone, the Glenwood Formation the near-shore facies of the Starved Rock

CHART A

Series	Stage	Formation	
Mohawkian	Shermanian	Kimswk	Wise Lake Formation
	Kirkfieldian		Dunleith Formation
	Rocklandian	Decorah Formation	
	Black Riveran	Plattin Limestone	
		Ancell Group	
Whiterockian Series		Everton Formation	

CHART B

Series	Stage	Formation	
Cinc	Maysvillian	Cape Limestone	
	Edenian	Kimswk	Wise Lake Formation
Mohawkian	Shermanian		Dunleith Formation
	Kirkfieldian		
	Rocklandian	Decorah Formation	
	Black Riveran	Plattin Limestone	
		Ancell Group	
Whiterockian Series		Everton Formation	

Figure 39. *Two charts of* **"Middle Ordovician"** *series and stages proposed for North America showing distribution of formations.* **Chart A** *is the Standard correlation (Ross et al., 1982);* **Chart B,** *the interpretation of Sweet and Bergström (1976).*

<table>
<tr><th>Northern</th><th colspan="2">East-central</th><th>Southeastern</th></tr>
<tr><td rowspan="2">Glenwood Formation</td><td rowspan="4">St. Peter Ss.</td><td rowspan="2">Starved Rock Member</td><td>Joachim Dolomite</td></tr>
<tr><td>Dutchtown Formation</td></tr>
<tr><td rowspan="2">St. Peter Sandstone
Kress Member</td><td>Tonti Member</td><td rowspan="2">St. Peter Sandstone</td></tr>
<tr><td>Kress Member</td></tr>
</table>

Figure 40. *Chart of formations in the Illinois Basin of the* **Ancell Group** *(Black Riveran Stage, Mohawkian Series) of Templeton and Willman (1963) projected to the Missouri section.*

offshore bar. Because the **Glenwood Formation** and the **Kingdom Member** occur only in the subsurface of northwestern Missouri and are not exposed in the state, they will not be discussed separately, but will be described with their facies, the Starved Rock and Joachim. The Tonti Member of the St. Peter forms the base of the Group.

Fraser (1976, p. 833) stated that in northern Illinois,

> "The Kress and Tonti Members were deposited as basal units during transgression over an erosional surface, and the Tonti Member accumulated as a sheet sand in progressively shallower water northward...The Starved Rock Member was deposited as a barrier-island complex, while the Glenwood Formation accumulated in a lagoon north of the barrier island."

In Missouri the Ancell Group consists of the following formations:

Joachim Dolomite (Glenwood Formation; northwestern Missouri)
Dutchtown Formation
St. Peter Sandstone
- Starved Rock Member
- Kingdom Member
- Tonti Member
- Kress Member

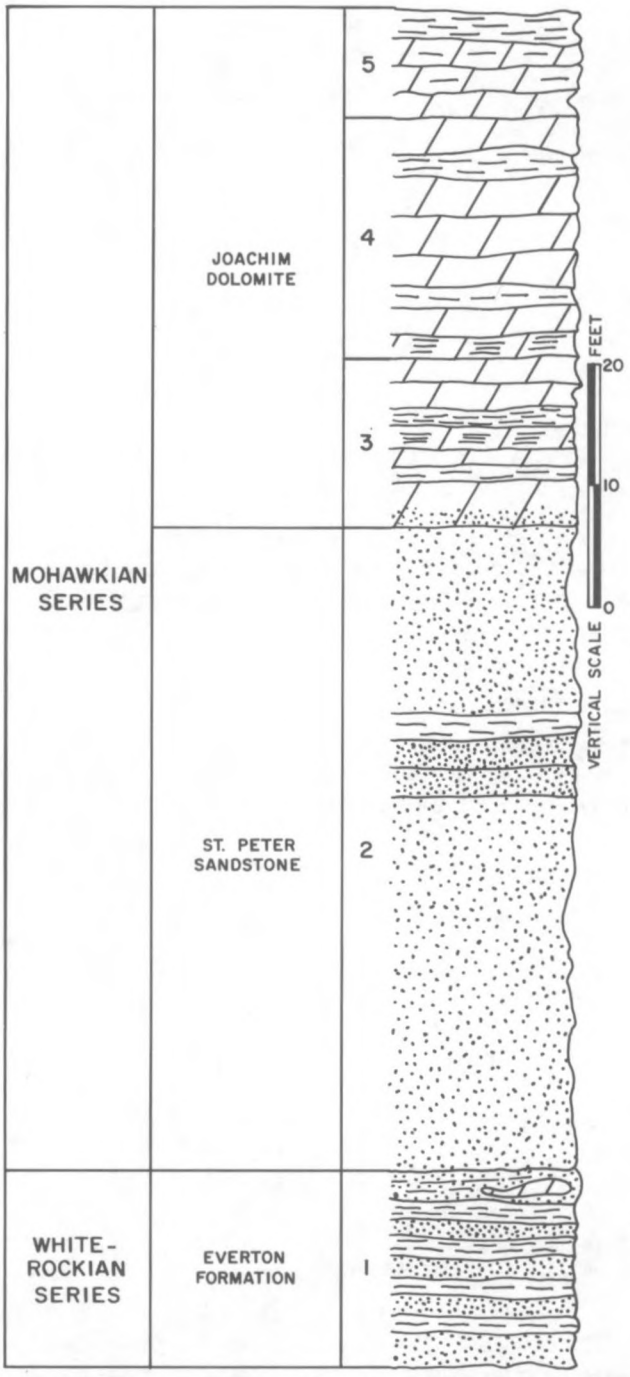
St. Peter Sandstone

Nicollet, 1843; Owen, 1847

Original description -- (Owen, 1847, p. 169-170) "Soft white ss. near Lake St. Croix, capped with shell lss. such as form upper portions of hills on Wisconsin River near Prairie du Chein and constitute whole of escarpment of St. Peters Falls as well as bluffs on both sides of the Mississippi, from whence to Carvers Cave and St. Pauls, and therefore sometimes alluded to by us under the local name **St. Peters fm.**"

Type section -- Stauffer (1934, p. 352) stated, "The type locality is at Fort Snelling, and the type section is that at the bluff where the Minnesota River joins the Mississippi River." Stauffer added, "The Minnesota River was formerly called the St. Peter's, and from the outcrop near its mouth the St. Peter sandstone was named."

Reference sections -- An excellent and complete exposure of the St. Peter Sandstone is in a roadcut on I-55 (figs. 41and 42A), beginning in the NW¼ NW¼ SW¼ sec. 34, and continuing into the S¼ NE¼ sec. 33, T. 40 N., R. 6 E., Jefferson County, Missouri, Selma 7½' Quadrangle.



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Joachim Dolomite

5. Dolomite, chocolate brown, finely crystalline; weathers buff; thin beds; becomes shaly toward top; weathers to nodular surface. (8 ft)
4. Dolomite and shale. Dolomite, bluish-gray, finely crystalline, fucoidal; weathers buff to light-tan; planar stromatolites near base; bedding massive. Interbedded shale, dark-gray; in 2-4 in. beds. (20 ft)
3. Dolomite, bluish-gray, finely crystalline, fucoidal; weathers buff; massive beds; stromatolitic in middle part; "birdseye" structures 10 ft above base; thin green shale partings. (13 ft 6 in.)

St. Peter Sandstone

2. Sandstone, medium-grained, poorly cemented; massive beds; grains rounded and frosted; 1.5-ft green shale reentrant 15 ft below top. (55 ft)

WHITEROCKIAN SERIES

Everton Formation

1. Sandstone and shale. Interbedded fine- to medium-grained sandstone with rounded and frosted quartz grains, and green silty to sandy shale; thin stringers of finely crystalline dolomite near top of unit; 2-ft green shaly sandstone bed at the top. (16 ft)

Figure 41. *A complete exposure of the* **St. Peter Sandstone** *in a roadcut on I-55, NW¼ NW¼ SW¼ sec. 34 to SE¼ NE¼ sec. 33, T. 40 N., R. 6 E., Jefferson County, east-central Missouri, Selma 7½' Quadrangle, mileage 170.4. Adapted from a description by Thacker and Satterfield (1977).*

A similar exposure is in a roadcut on the east side of I-55 in the center west line NW¼ sec. 11, T. 38 N., R. 7 E., Ste. Genevieve County, Missouri, Bloomsdale 7½' Quadrangle (fig. 42B); Everton, St. Peter, and Joachim are exposed.

Other good exposures of the St. Peter Sandstone can be seen in the town of Pacific, eastern Franklin County, and around Crystal City, Jefferson County, where it has been extensively mined.

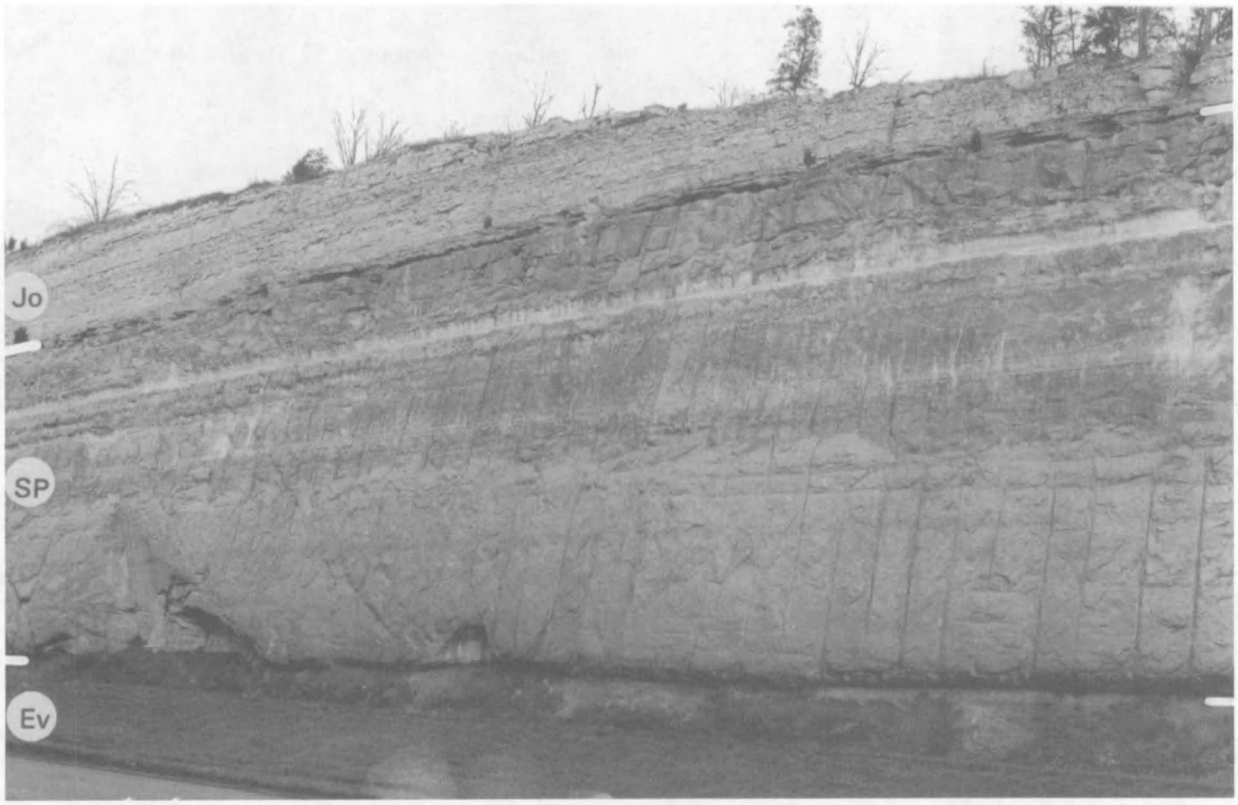


Figure 42 (A) ▲ Figure 42 (B) ▼

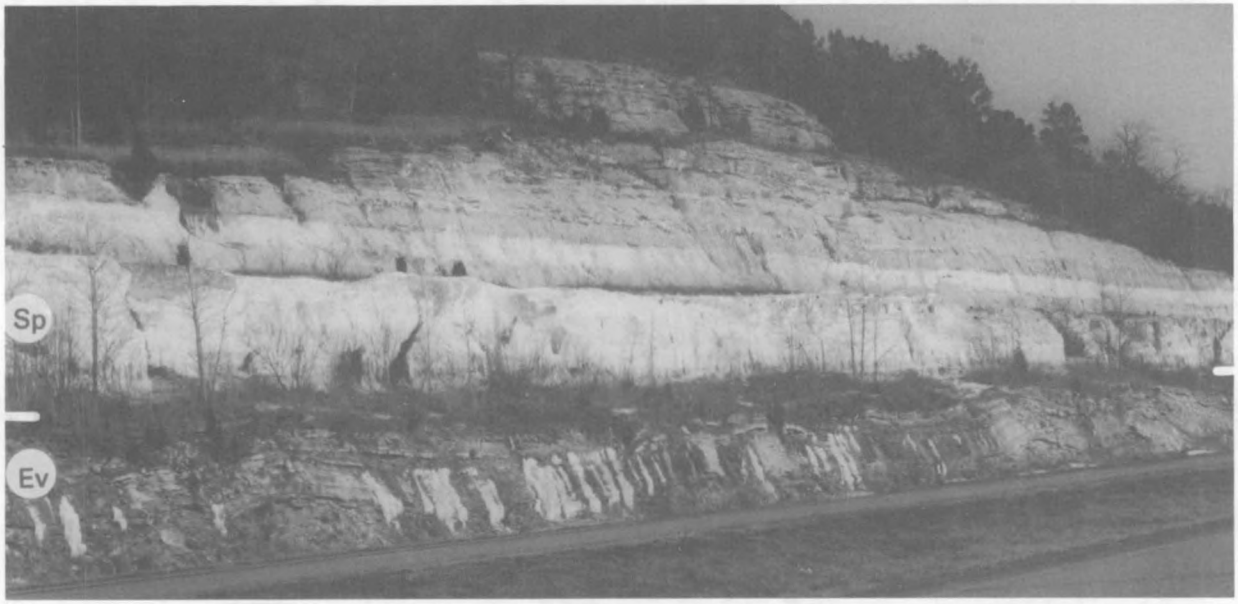


Figure 42. **St. Peter Sandstone** *exposed in roadcuts on I-55, southeastern Missouri.* **(A)** *Everton Formation, St. Peter, and Joachim Dolomite at mileage 170.4, NW¼ NW¼ SW¼ sec. 34 to SE¼ NE¼ sec. 33, T. 40 N., R. 6 E., Jefferson County, Selma 7½' Quadrangle (fig. 41).* **(B)** *Everton Formation and St. Peter, center west line NW¼ sec 11, T. 38 N., R. 7 E., Ste. Genevieve County, Bloomsdale 7½' Quadrangle.* **(Ev)** *Everton Formation;* **(SP)** *St. Peter Sandstone;* **(Jo)** *Joachim Dolomite. Photographs by T.L. Thompson.*

History of nomenclature

1843	**Nicollet**	**"the geological formation St. Peters" (in Minnesota)**
1847	**Owen**	**St. Peters formation**
1851	King	Rock Fort sandstone
1855	Shumard	Saccharoidal sandstone
	Swallow	Saccharoidal Sandstone (upper part; southeastern Missouri)
		Saccharoidal Sandstone (northwestern Missouri)
	Meek (*in* Swallow)	1st, or Saccharoidal sandstone
1873	Pumpelly	Saccharoidal sandstone (upper part)
1891	Walcott	3rd sandstone
1892	Nason	Roubidoux sandstone (part; some sections)
1894	Winslow	Roubidoux or Saccharoidal sandstone (part)
		Crystal City sandstone (upper part)
1895	Keyes	First or Saccharoidal sandstone ("= St. Peter sandstone")
1898	Keyes	Saccharoidal or Roubidoux sandstone (upper part)
		Cape-au-Gres sandstone
	Marbut	Saccharoidal or Roubidoux sandstone (upper part)
	Shepard	1st sandstone (upper part)
1900	Gallaher	St. Peter sandstone (upper part; **first use of name in Missouri**)
1903	Ball and Smith	Pacific sandstone
1904	Buckley and Buehler	St. Peter or Pacific sandstone (upper part)
1905	Van Horn and Buckley	St. Peters (Pacific) sandstone
	Bain and Ulrich (a, b)	St. Peter ("Crystal City") sandstone
1908	Buckley	St. Peter sandstone (upper part)
1911	Ulrich (b)	St. Peter sandstone (**restricted to present definition**)
1918	Branson	St. Peter sandstone (upper part)
1961	Martin et al. (a)	St. Peter formation
1963	Templeton and Willman	St. Peter Sandstone
		Starved Rock Sandstone Member
		Tonti Sandstone Member
		Kress Member
1978	Groves	St. Peter Sandstone (unpublished manuscript)
		Starved Rock Member
		Kingdom Member
		Tonti Member
		Kress Member
1982	Thompson	St. Peter Sandstone
1986	Nunn	Starved Rock Sandstone (northeast Missouri)
		Glenwood (northeast Missouri)
		St. Peter Sandstone (northeast Missouri; =Tonti Member of St. Peter Sandstone)
1991	**Thompson (present report)**	**St. Peter Sandstone**
		Starved Rock Member
		Kingdom Member
		Tonti Member
		Kress Member

Remarks -- As described by Martin et al. (1961a, p. 25), in Missouri,

"The St. Peter is typically a well-sorted, quartzose sandstone but locally is an orthoquartzite. The sand grains are fine to medium in size, rounded, spherical, and characteristically frosted. The formation's silica content

is as high as 99 percent. A freshly exposed surface of the formation is commonly white with shades of pink and green. Weathered surfaces are a dirty gray or brown and are case-hardened at many localities. Bedding is indistinct, and the formation appears massive throughout. The rock is cross bedded and ripple marked locally. The formation is generally porous and permeable except where it is an orthoquartzite."

Templeton and Willman (1963) divided the St. Peter Sandstone into two sandstones. Previously, most geologists associated the name "St. Peter" with a very pure, well-sorted, cross-bedded, friable quartz sandstone, although a few (Lamar, 1927, p. 50) reported beds of shaly or thin-bedded sandstone in approximately the middle portion of the St. Peter in some regions. According to Templeton and Willman (1963, p. 39-42),

"From north-central Illinois to southeastern Missouri, the St. Peter Sandstone above the Kress Member consists of a lower fine-grained unit [Tonti Member] and an upper medium-grained unit [Starved Rock Member]...In Missouri, McQueen tentatively assigned the fine-grained unit to the Everton Formation. However, subsurface studies in Illinois and tracing in outcrops northward to Minnesota show that the fine-grained sandstone is the St. Peter Sandstone of the type area. The medium-grained sandstone is younger than the type St. Peter Sandstone and is absent in the type St. Peter region. The medium-grained unit, from its area of maximum development in north-central Illinois, grades northward into the Glenwood Formation and southward into the Dutchtown and Joachim Formations."

Templeton and Willman (p. 39-42) continued,

"Between McDonough and Scott Counties, western Illinois, and in southeastern Missouri the Starved Rock Sandstone rests on the Tonti Sandstone with a sharp contact, which suggests the presence of a minor diastem. North of McDonough County the Starved Rock conformably overlies the Kingdom Sandstone [Member]."

In a study of residues from wells in northern Missouri, Groves (1978) found evidence of a sandstone succession with a thin green shale interval in the middle third. In some wells, the lower sand and green shale have previously been correlated with the **Everton Formation**, but Groves (1978) defined this succession to be the two sandstone members of the St. Peter Sandstone as defined by Templeton and Willman

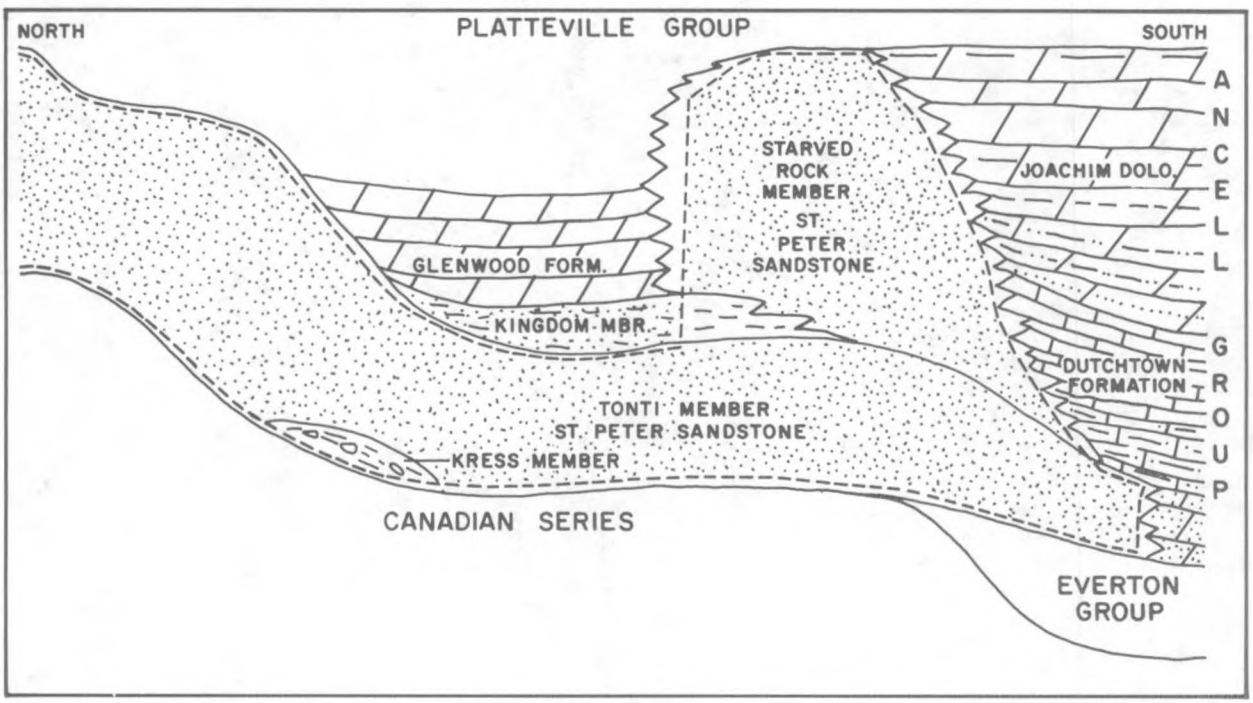


Figure 43. *Diagrammatic section by Templeton and Willman (1963, p. 37) showing relations of units in the* **Ancell Group** *in the Illinois Basin. The "bar" represented by the Starved Rock Member of the St. Peter Sandstone is apparent in this illustration.*

(1963) and Buschbach (1964). Templeton and Willman (1963) formally named the two sandstone members of the St. Peter the **Tonti Member** (lower member) and the **Starved Rock Member** (upper member). North of McDonough County, Illinois, the two are separated by the green shaly sandstone or sandy shale of the **Kingdom Member**; the latter is identified as a member of the **Glenwood Shale** in northwestern Illinois and Iowa. In northern Missouri, the Kingdom interval extends southward or southeastward into the St. Peter depositional region; therefore, the Kingdom, although a member of the Glenwood Shale in Iowa and Illinois, is considered a member of the St. Peter Sandstone in Missouri (fig. 43).

From an unpublished manuscript of Buschbach (later published in 1964), Templeton and Willman (1963) named the rubble zone at the base of the St. Peter the **Kress Member** of the St. Peter Sandstone. In the subsurface of northern Missouri, beneath basal St. Peter Sandstone, numerous wells encounter a post-Canadian residual zone that can be identified as the Kress Member. The **St. Peter Sandstone** therefore comprises the following units in Missouri:

Starved Rock Member
Kingdom Shale Member
Tonti Member
Kress Member ("detrital zone")

In southeastern and eastern Missouri, the Joachim Dolomite conformably overlies the Tonti Member. North of the area where the Joachim grades laterally into the Starved Rock Member, the Starved Rock lies

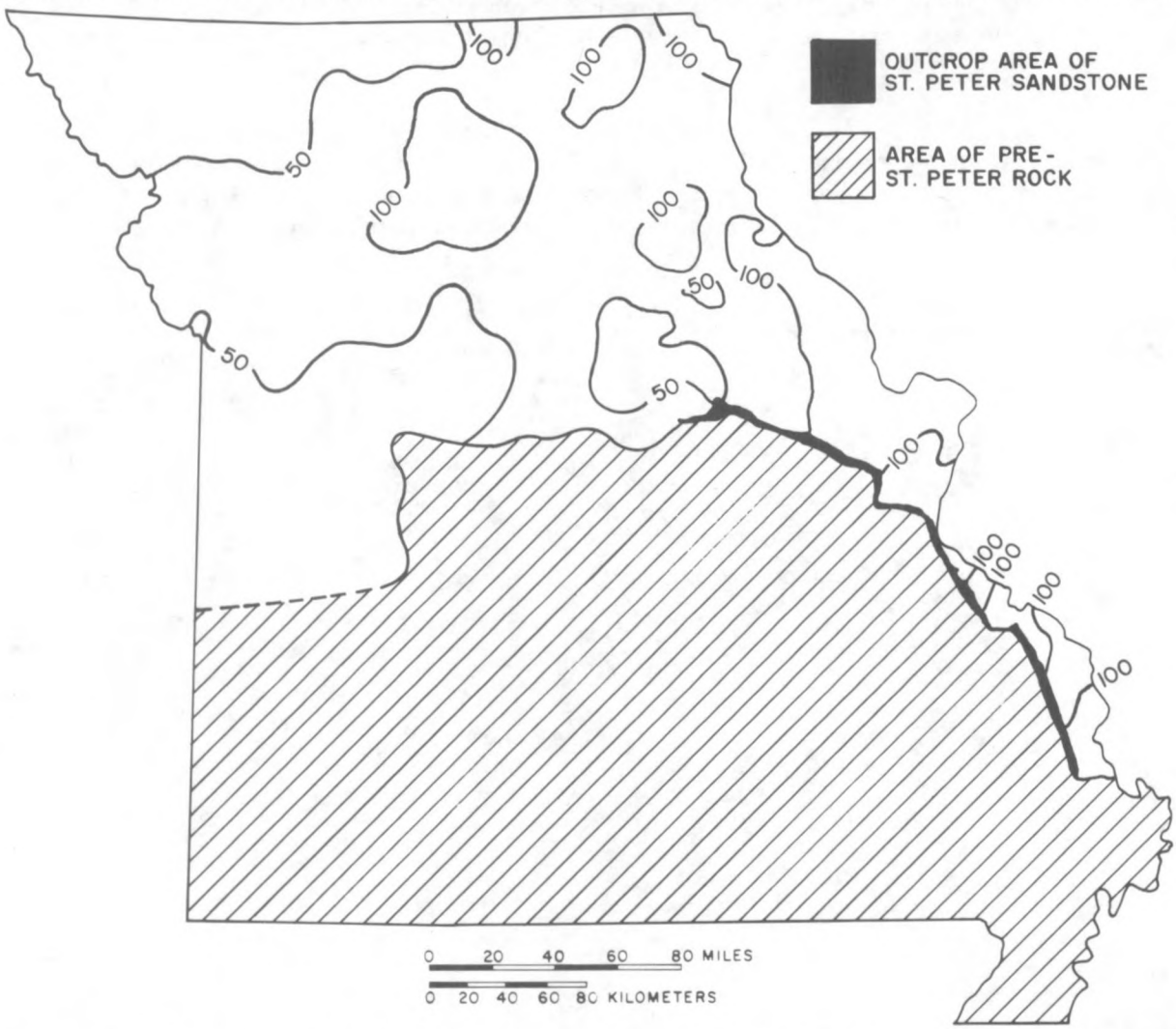


Figure 44. *Isopach map, distribution, and areas of outcrop of the* **St. Peter Sandstone** *in Missouri. Isopach interval is 50 ft.*

on the Tonti; the two sandstones are separated by the **Kingdom Member** (a tongue of the Glenwood), which grades northward from the Starved Rock into the Glenwood Shale.

St. Peter outcrops extend from southeastern and east-central Missouri, westward to the west-central part of the state (fig. 44). They consist only of the Tonti Member, except possibly for one or two isolated outcrops of Starved Rock in the region of Dutchtown, southern Cape Girardeau County, southeastern Missouri. The thickness of the formation (fig. 44) varies from less than 10 to more than 100 ft. Its average thickness in the outcrop area is between 60 and 70 ft. The very irregular base reflects numerous channels in the underlying strata.

Kress Member of St. Peter Sandstone

Templeton and Willman, 1963; Buschbach, 1964

Original description -- (Templeton and Willman, 1963, p. 45) "The Kress Member in places is a coarse basal conglomerate consisting largely of a rubble-like deposit of irregular blocks of chert with a matrix of clay, sand, or chert. This material is residual from solution of the underlying cherty dolomites and sandstones and is concentrated in solution depressions or along valley channels."

Type section -- Templeton and Willman (1963, p. 45) stated, "The Kress Member of the St. Peter Sandstone was named for Kress Creek, northwest of West Chicago, in DuPage County [Illinois], near which a well of the Elgin, Joliet, and Eastern Railroad encountered 64 feet of typical conglomerate (NW NE SE 32, 40N-9E, Wheaton Quad., SS-1169, 940-1004') (Buschbach, in press [1964])."

History of nomenclature

1963	**Templeton and Willman**	**Kress Member of St. Peter Sandstone**
1967	Ostrom	Readstown Member of St. Peter Sandstone (in Wisconsin)
1978	Groves	Kress Member of St. Peter Sandstone (in Missouri; unpublished manuscript)
1991	**Thompson (present report)**	**Kress Member of St. Peter Sandstone**

Remarks -- Ostrom (1967) named a basal conglomerate of the St. Peter Sandstone the **Readstown Member**, exposed in the vicinity of Readstown, on the east side of Highway 14, center NE¼ sec. 27, T. 12 N., R. 4 W., Vernon County, Wisconsin. Ostrom rejected the name "Kress" because the type section is a well, not an outcrop.

Groves (1978, unpublished manuscript) identified the Kress Member in Missouri, and described it as follows:

> "[In Missouri] The Kress Member is best developed, and most frequently encountered in well samples, in the Cooper, Pettis, and Saline County area which is on the northwest flank of the Ozark uplift. This area is just south of where the St. Peter Sandstone is present as a sheet-like deposit...In 13 of 20 wells the basal conglomerate--the Kress--is present..."
>
> "It is present rather infrequently in Boone County, and in east-central Missouri where it is somewhat thinner.
>
> "The Kress Member in Missouri is an incompetent conglomerate, derived from the dolomites of the pre-existing Canadian Series, and consists of (varying amounts of) slightly weathered dolomite, chert, green shale, and sand. The cherts are typical of those seen in the insoluble residues of the Jefferson City, Cotter formations. These cherts may be translucent, smooth, rough, oolitic, sandy quartzose, and quartzose oolitic. The shales are usually a light to medium green, non-bedded, and may contain some quartz sand. The sand typically is rounded and frosted, and in the size range of 0.1 to 1.5 mm., with a median diameter of 0.34 mm. Polished sand is almost never seen in this interval. The Kress usually contains small amounts of chert and shale, with much sand, at the top of the member, and increasing amounts of chert and shale with less sand toward the base, notibly so when the unit is more that 15 feet in thickness. At times the basal 5 to 10 feet are nearly 100% chert."

The Kress Member of the St. Peter Sandstone is the detrital zone at the top of the Canadian succession where Canadian is directly overlain by the St. Peter. It is underlain unconformably by rocks of the Canadian Series: the Jefferson City Dolomite in northwestern Missouri, the Cotter Dolomite in the Cooper-Pettis-Saline county area, and the Cotter and/or Powell Dolomite in east-central Missouri. The Kress may be overlain by St. Peter Sandstone, or by Devonian or Mississippian limestones where the St. Peter has been removed.

Tonti Member of St. Peter Sandstone

Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 46) "The Tonti Sandstone consists chiefly of fine-grained, well sorted, friable sandstone. Beds that are principally medium to coarse-grained occur locally at various stratigraphic positions, but they form only a minor constituent in the dominantly fine-grained member. In parts of western Illinois, much of the Tonti Sandstone is very silty. Because the Tonti extends much more widely than the Starved Rock, the description of the St. Peter as a whole largely applies to the Tonti."

Type section -- Templeton and Willman (1963, p. 45) stated, "The Tonti Sandstone Member of the St. Peter Sandstone is here named for Tonti Canyon in Starved Rock State Park in LaSalle County, Illinois. The top of the sandstone is exposed at the mouth of the canyon, but the type section is in the Starved Rock section where its relation to the Starved Rock Sandstone is better exposed. The Tonti is completely exposed in the Split Rock section, 4 miles northwest of Starved Rock."

The Starved Rock section is located as follows by Templeton and Willman (1963, p. 225): "Exposures at Starved Rock, Lovers' Leap, and French Canyon in Starved Rock State Park, LaSalle County, Illinois (W½ NW and NW NW SW 22, 33N-2E, Ottawa Quad.)."

Reference sections -- The exposure located under "Reference sections" of the **St. Peter Sandstone** (figs. 41 and 42A) is the best exposure of the Tonti Member of the St. Peter Sandstone in Missouri. The Tonti Member is also well-exposed in western St. Louis and eastern Franklin counties, where it is mined as a glass sand.

History of nomenclature

1963	**Templeton and Willman**	**Tonti Sandstone Member of St. Peter Sandstone**
1978	Groves	Tonti Sandstone Member of St. Peter sandstone (unpublished manuscript; **first identification in Missouri**)
1983	Okhravi and Carozzi	Tonti Sandstone
1986	Nunn	St. Peter Sandstone (northeast Missouri)
1991	**Thompson (present report)**	**Tonti Member of St. Peter Sandstone**

Remarks -- Characteristically finer grained than the overlying Starved Rock Member, the **Tonti Member of the St. Peter Sandstone** is the typical "St. Peter Sandstone" that covers much of the Midcontinent region. It lies unconformably on the Everton Formation in parts of east-central Missouri, and on detritus of the pre-St. Peter erosional surface on the older Canadian strata (Kress Member) in eastern and central Missouri (fig. 40). The Tonti Member is present throughout the subsurface in northeastern, southeastern, northern, northwestern, and west-central Missouri (fig. 44), whereas the Starved Rock Member is restricted to an elongate subsurface distribution from northeastern Missouri southwestward and westward, and to a small pocket in southeastern Missouri. Where Starved Rock is present, the Tonti Member was often previously identified as "Everton," and the overlying Starved Rock Member was considered "classical" St. Peter Sandstone.

Starved Rock Member of St. Peter Sandstone

Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 47) "The Starved Rock Member consists of sandstone that closely resembles the underlying sandstone in the Tonti Member, but is consistently coarser grained. The dominant size grade is medium in western Illinois and medium, locally coarse, in northern Illinois (Willman & Payne, 1942, p. 73-76). In western Illinois and around the margins of the formation in north-central and northeastern Illinois the sandstone is partly silty, locally fine grained, and contains tongues of Glenwood sandstones, but it maintains its character as a coarse-grained unit. As a rule the Starved Rock Sandstone lacks the strong cross-bedding that is locally prominent in the underlying Tonti Sandstone."

Type section -- Templeton and Willman (1963, p. 46) stated the member was "... named for Starved Rock in Starved Rock State Park, LaSalle County, north-central Illinois." The Starved Rock type section is located by Templeton and Willman (1963, p. 225) as "Exposures at Starved Rock, Lovers' Leap, and French Canyon, in Starved Rock State Park, LaSalle County, Illinois (W½ NW and NW NW SW 22, 33N-2E, Ottawa Quad.)."

History of nomenclature

1963	**Templeton and Willman**	**Starved Rock Sandstone Member of St. Peter Sandstone**
1978	Groves	Starved Rock Member of St. Peter Sandstone (unpublished manuscript; **first identification in Missouri**)
1983	Okhravi and Carozzi	Starved Rock Sandstone
1986	Nunn	Starved Rock Sandstone
1991	**Thompson (present report)**	**Starved Rock Member of St. Peter Sandstone**

Remarks -- Nunn (1986) presents the best interpretation of the Starved Rock:

> "The Middle Ordovician Starved Rock Sandstone occupies an elongate belt which extends from Chicago, Illinois to Kansas City, Missouri. It is mainly quartz arenite with subordinate shale laminae, shale beds, and mottled sandstone-shale beds most commonly found along its northwestern margin in Iowa. The Starved Rock is confined to the subsurface except in La Salle County, Illinois.
>
> "The Starved Rock is reinterpreted as representing a marine bar complex. Evidence for emergence of the Starved Rock, in the form of aeolian depositional features, is lacking. This bar complex formed in a broad epicontinental sea, between an area of carbonate deposition to the south [Joachim] and an area of mud deposition shoreward to the north [Glenwood]. The depositional area of the Starved Rock was within the southern tropical trade wind belt where prevailing easterly winds and currents may have moved sand to the present southwest. Stratigraphic and grain size studies indicate the bar complex prograded over the southernmost edge of the Glenwood Shale in southeastern Iowa and adjacent areas of Illinois and Missouri. The Starved Rock was deposited during a relative stillstand of sea level.
>
> "The siliciclastic sources for the Starved Rock were probably the St. Peter Sandstone [Tonti Member] and Prairie du Chien Group in southern Michigan, northern Indiana, and southern Lake Michigan. Cambrian rocks may have also been a source in extreme southeastern Michigan.
>
> "Sedimentary structures, including herringbone cross-beds, suggest a tidal influence in sand deposition. Storms probably also affected sediment deposition. Parts of the bar complex, especially near the northwestern margin, were deep enough to allow preservation of organic material in reducing environments, below the oxidizing effects of waves or currents. Burrowing organisms left trace fossils and created mottled sandstone-shale beds. A renewed rise of sea level led to carbonate deposition above the Starved Rock, as siliciclastic influx decreased.
>
> "Few diagenetic alterations were found in outcrop. Diagenetic alterations in the subsurface included the common formation of quartz overgrowths; with much less common chert cement, carbonate cement, minor authigenic clay, pyrite, and oil. Most of the clay in the Starved Rock is detrital."

Not present in outcrop in Missouri, except possibly for a few small isolated exposures near Dutchtown in southern Cape Girardeau County, the Starved Rock Member of the St. Peter Sandstone is an elongate

sand body that extends through the subsurface of northern Missouri (fig. 45), a continuation of the Starved Rock of northern Illinois.

The Starved Rock, 20-70 ft thick, has been identified in the subsurface of north-central and northeastern Missouri; it has also been identified in Cape Girardeau and Ste. Genevieve counties (Bell et al., 1964) beneath the Joachim Dolomite. Facies on either side of the Starved Rock Member (figs. 40 and 43) are those of the Glenwood Shale to the north and west, and the Joachim Dolomite and Dutchtown Formation to the south and east. The **Glenwood**, known only from the subsurface of northwestern Missouri, is interpreted as representing a coastal lagoon environment separated from the open sea by the barrier created by the Starved Rock Member of the St. Peter Sandstone.

Figure 45. *Map of northern Midcontinent area showing the distribution of the* **Starved Rock Member** *of the* **St. Peter Sandstone**. *Adapted from an illustration by Nunn (1986).*

Dutchtown Formation

McQueen, 1937

Original description -- (McQueen, 1937, p. 14-15) "The Dutchtown formation contains comparatively pure limestone, highly argillaceous limestones, magnesian limestones, dolomites, and dolomitic sandstone. All of them, with the possible exception of the sandstone, are characteristically marked by minute particles of disseminated organic matter. Grains of sand are common in the carbonate rocks...Silt and clay also occur as component parts of these rocks, the amount varying considerably throughout the section. The limestones and dolomites are generally dark-colored, with brown, dark-blue, and black predominating."

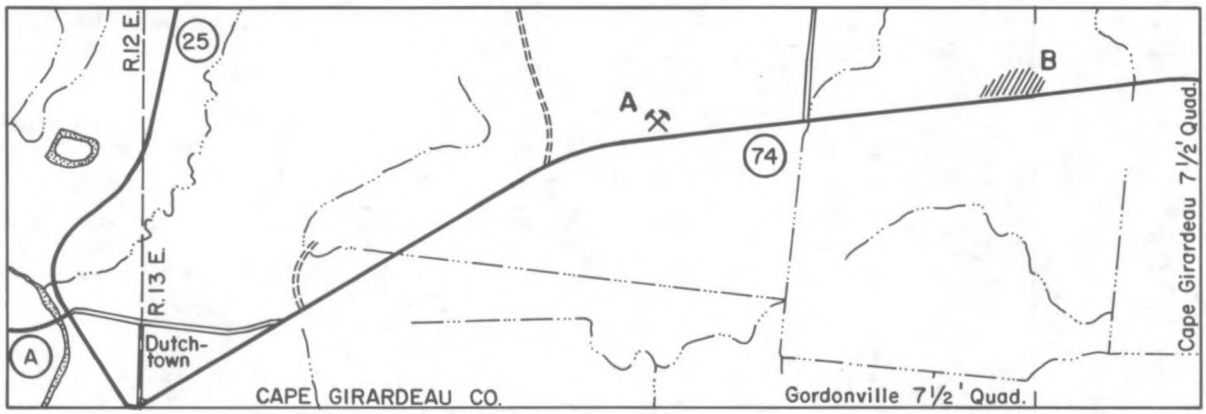
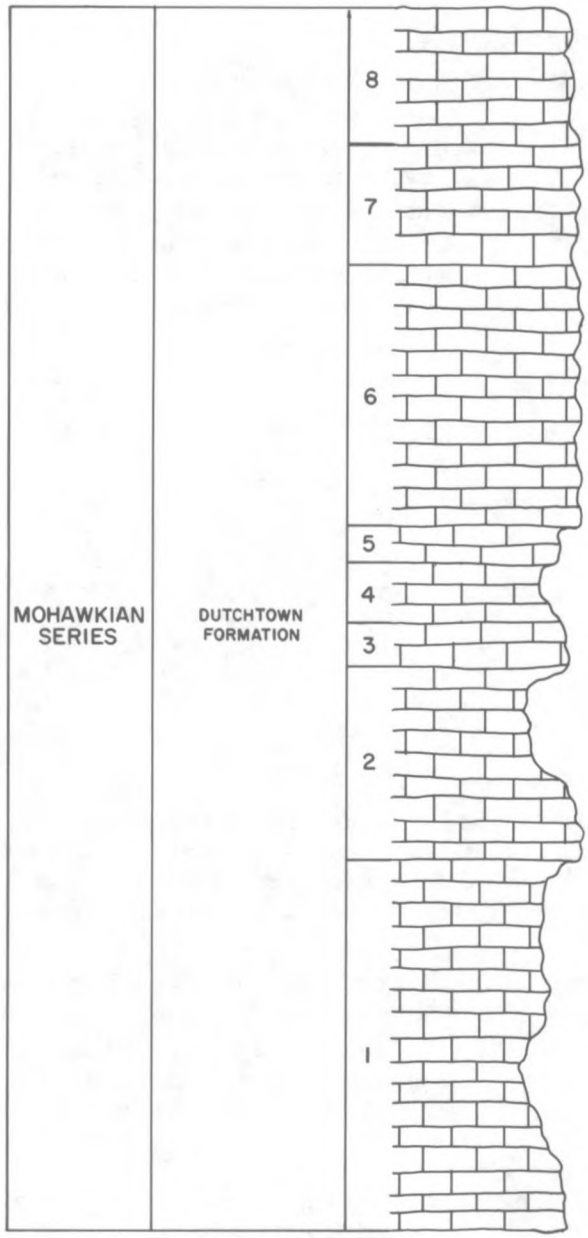


Figure 46. *Parts of the Gordonville and Cape Girardeau 7½' quadrangles showing the locations of the type sections of:* (A) *the* **Dutchtown Formation,** *in the Geiser Quarry, north side of Missouri Highway 74, 1.25 mi east of Dutchtown, SE¼ NW¼ sec. 20, T. 30 N., R. 13 E.; and* (B) *the* **Abernathy Member of the Joachim Dolomite,** *a small roadcut on Highway 74, SE¼NW¼SE¼ sec. 20, T. 30 N., R. 13 E. (projected), Cape Girardeau County, southeastern Missouri.*

Type section -- The Dutchtown Formation was named from the village of Dutchtown, Cape Girardeau County, Missouri. McQueen (1937, p. 13) located the type section at "...the abandoned quarry on the Arnold Geiser farm in the southeastern portion of the U.S. Survey 214 (SE¼, NW¼, NW¼ sec. 20, T. 30 N., R. 13 E.), and approximately one and three-tenth miles east of the village of Dutchtown on State Highway No. 74..." This quarry is on the north side of Highway 74 in the Gordonville 7½' Quadrangle (figs. 46 and 47).

History of nomenclature

1894	Winslow	Joachim dolomite (lower part)
1921	Dake	"transition zone between St. Peter and Joachim" in St. Peter group
1937	**McQueen**	**Dutchtown formation** upper unnamed member Geiser Quarry member lower unnamed member
1939	McQueen	Dutchtown formation
1946	Youngquist and Cullison	Dutchtown formation
1961	Martin et al. (a)	Dutchtown formation
1963	Templeton and Willman	Dutchtown Limestone ("= lower part of Glenwood Formation"; middle Ancell Group) Sharpsboro Member Gordonville Member
1982	Thompson	Dutchtown Limestone
1984	Klapper and Bergstrom	Dutchtown Formation
1991	**Thompson (present report)**	**Dutchtown Formation**



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
Dutchtown Formation
Upper Member [Sharpsboro Member]

8. Limestone, grayish-blue and brown, lithographic, dense, argillaceous; breaks with a conchoidal fracture and thin splintery edges; weathers buff; contains thin buff clay partings. (1 ft 9 in.)
7. Limestone, light-bluish and brownish-gray, lithographic, dense, massive; ½ in. darker blue bands parallel to bedding; weathers along darker colored bands into thin 3-in. beds; thin shale partings common; upper and lower parts fossiliferous, with crystalline calcite. (1 ft 8 in.)
6. Limestone, dense; like no. 2; best exposed on vertical face along joint plane striking N. 45° W., weathers along shaly partings into 2-12 in. beds. (3 ft 6 in.)
5. Limestone, buff, fissile, shaly. (1 in.)
4. Limestone, brown, lithographic; contains small flat gastropods. (9 in.)
3. Limestone, shaly, like no. 4. (2 in.)
2. Limestone, dark-blue to brown, dense to finely crystalline, slightly granular in upper part; single bed; gastropods and pelecypods common; limestone shingle-type conglomerate near base. (2 ft 6 in.)

Lower Member [Gordonville Member]

1. Limestone, dark-blue to black, very nodular; weathers to 6-in. beds, with thin, dark-brown shaly partings; ostracodes common in limestone, conodonts in shale; locally exhibits a wavy-bedded, reef-like appearance; calcite-encrusted partings; calcite-lined vugs; asphalt occasionally in vugs. (5 ft)

Total thickness exposed 15 ft 5 in.

Figure 47. *Type section of the* **Dutchtown Formation** *(fig. 46). Adapted from descriptions by Cullison (1938, p. 220) and McQueen (1939, stop 30, p. 66). Not to scale.*

Remarks -- Martin et al. (1961a, p. 26) described the Dutchtown Formation in Missouri as follows:

"The Dutchtown formation is composed dominantly of medium to thinly bedded limestone and dolomite and contains varying amounts of dolomitic sandstone, siltstone, shale, and clay. The color of the rock is dark blue, gray, or black. The carbonate rocks contain finely disseminated particles of organic matter and hydrocarbons in the form of asphaltic-filled vugs. Both the limestone and dolomite give off a petroliferous odor when struck with a hammer. The limestone, dolomite, and sandstone are all fossiliferous, though well-preserved fossils are scarce. Pelecypods and gastropods are the most abundant fossils. Masses of *Cryptozoon* are present in the lower part of the formation at a few localities.

"The Dutchtown formation is best developed in Scott, Cape Girardeau, and Perry Counties, Missouri, and in southwestern Illinois. Outcrops are few, and information on the distribution and lithology of the formation is based largely on subsurface data..."

"The formation attains a maximum thickness of approximately 170 ft in southern Cape Girardeau County. It thins rapidly northward and is only 20 ft thick in southern Perry County. It is apparently absent from Perryville northward. South of Cape Girardeau County, the Dutchtown is present only in northeastern Scott County."

McQueen (1937) divided the Dutchtown Formation into three members, based on distinctive insoluble residue zones: a lower silty to sandy, dark-gray limestone; a middle, less sandy, locally calcarenitic limestone (**Geiser Quarry Member**); and an upper limestone member, which is also less sandy and is darker than the other two members. In 1939, McQueen redescribed the lower two members of the Dutchtown (fig. 47) from the Geiser quarry.

Templeton and Willman (1963, p. 53-54) recognized two members in the Dutchtown: the lower (**Gordonville Member**), corresponding to McQueen's lower silty and sandy limestone member, and the upper (**Sharpsboro Member**), corresponding to the upper two, less sandy and silty limestone members of McQueen. The type section for both members is the same as for the formation: the Geiser quarry east of Dutchtown.

Templeton and Willman (1963, p. 54) stated,

"Southward from Cape Girardeau, southeastern Missouri...and in southern-most Illinois the Dutchtown rests on St. Peter Sandstone [restricted; Tonti Member] with a sharp contact that suggests a diastem. North of Cape Girardeau and southernmost Jackson County, Illinois, the Dutchtown appears to grade laterally from the base upward into the lower part of the Starved Rock Sandstone...and it disappears a short distance farther north [central Perry County]. In southern Illinois the contact between the Dutchtown and the overlying Joachim Dolomite is conformable. In places it also is gradational and is characterized by interbedding of the two lithologic types. The conformability of the contact accords with the view that the Starved Rock Sandstone is the shoreward facies of the two formations."

The northernmost-known exposures of the Dutchtown are in the Crosstown 7½' Quadrangle, southern Perry County.

In addition to megafossils, conodonts have been described from Dutchtown strata in southeastern Missouri (Cullison, 1938; Youngquist and Cullison, 1946).

Joachim Dolomite

Winslow, 1894

Original description -- (Winslow, 1894, p. 353) "Over half a mile beyond this, in a deep rock cut crossed by a wagon bridge, about 20 ft of thin, argillaceous, shaly, magnesian limestone (JOACHIM) is exposed, containing some free calcite, but no chert. The beds dip slightly northward. A mile or so east, at the mouth of Plattin creek, the rocks in the bluff are seen to dip about 5-degrees NE."

Type section -- The Joachim Dolomite was named for exposures that Winslow presumed were along Joachim Creek, Jefferson County, Missouri. Grohskopf (1948, p. 362) stated, "Actually, the type section named and described by Winslow is on Plattin Creek. However, the 'Joachim' formation does crop out along Joachim Creek about one mile south of Herculaneum and approximately 3 miles north of his described section." The type section is in the NE¼ sec. 8 and NW¼ sec. 9, T. 40 N., R. 6 E., Festus 7½' Quadrangle (fig. 48). This section, a poor representative for the formation, was described by Winslow as follows:

JOACHIM LIMESTONE
High hill with occasional exposures of magnesian limestone.
Magnesian limestone, rugged. (3 ft)
CRYSTAL CITY SANDSTONE
Sandstone, thinly bedded, somewhat shaly. (3 ft)
Magnesian limestone, dense, hard. (12 ft)
Sandstone, massive, friable, indurated in places. (20 ft)
Magnesian limestone, dense; sandy layers near the top, and pebbles like quartzite. (10 ft)
Magnesian limestone, irregularly and thinly bedded. (20 ft)
Slope to the bed of Plattin creek. (10 ft)

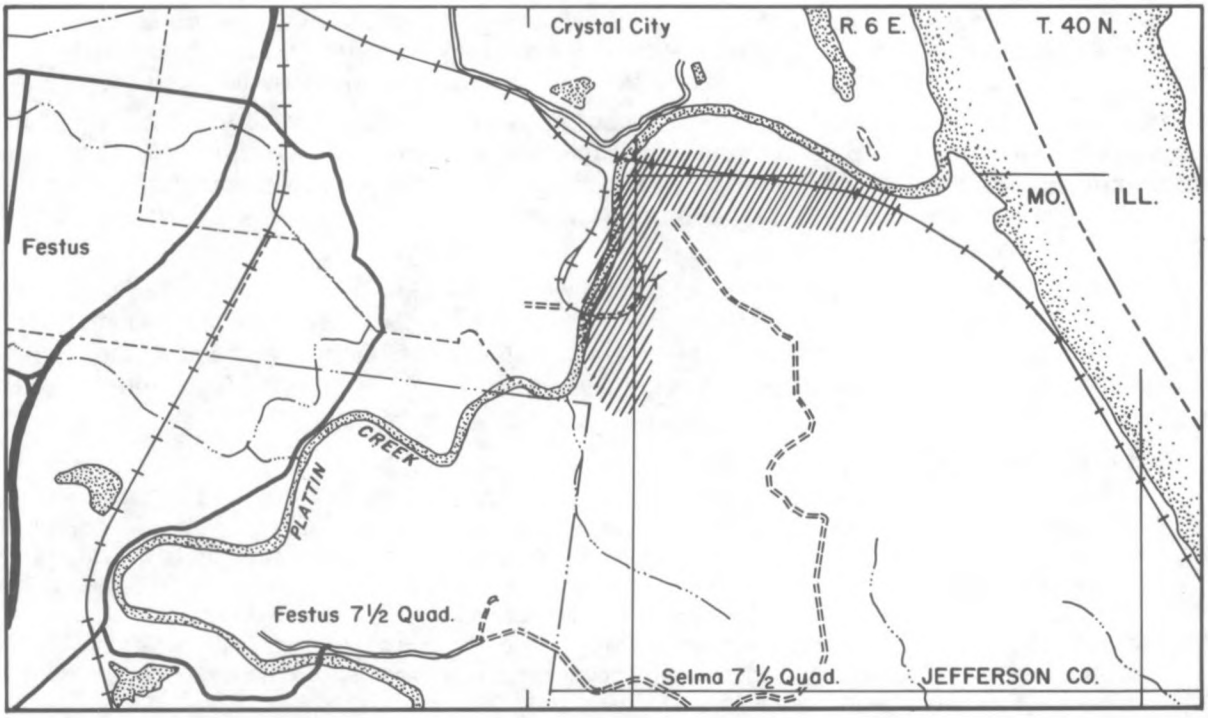


Figure 48. *Adjacent parts of the Selma and Festus 7½' quadrangles, showing the approximate location of the type section of the* **Joachim Dolomite** *along Plattin Creek, Jefferson County, east-central Missouri.*

Reference sections -- The type section is incomplete, exposing only the lower part of the Joachim Dolomite. Templeton and Willman (1963, p. 55) stated that "...a better reference section is found in the Ancell type section--the bluffs and quarries on the north side of State Highway 74 east of Dutchtown in Cape Girardeau County, southeastern Missouri (between SE NW NE 20 and SW NE NE 22, 30N-13E, Cape Girardeau Quad)." This includes two exposures: a small bluff (NE¼ NE¼) and a small quarry (NW¼ NE¼) in the NE¼ sec. 22, T. 30 N., R. 13 E. The bluff is composed of upper Joachim and possibly the lower part of the "Pecatonica Formation." The quarry, the Arnold Quarry, exposes 70 ft of Joachim and lower "Pecatonica."

The type Ancell region is not a good area to see "typical" Joachim strata. The following sections are more representative of the Joachim over most of eastern Missouri:

1). Basal Joachim (Augusta Member, fig. 49A) is exposed in a roadcut on I-55, 1.5 mi south of the Highway Z interchange at Pevely, SW¼ SW¼ sec. 19 and NW¼ NW¼ sec. 30, T. 41 N., R. 6 E. (projected), Franklin County, Missouri, Herculaneum 7½' Quadrangle, less than 6 mi north of the type area.

2). "Middle" and "upper Joachim" are well exposed in St. Louis County, in roadcuts on I-44 east of the Pacific interchange, NE¼ NW¼ sec. 12 and SE¼ SE¼ sec. 1, T. 43 N., R. 2 E., Pacific 7½' Quadrangle (fig. 49B) and in an abandoned railroad cut immediately east of the small town of Glencoe, center NW¼ sec. 19, T. 44 N., R. 4 E., Manchester 7½' Quadrangle (fig. 50).

3). "Middle" and "upper Joachim" members were exposed in recent construction (winter of 1989) at the interchange of I-44 and Missouri Highway 109 just east of Eureka, SW¼ sec. 31, T. 44 N., R. 4 E., St. Louis County, Manchester 7½' Quadrangle. A discontinuous chert band is present in the middle of the "middle Joachim" at this section; this chert served as the marker for the base of the former, now abandoned, "Rock Levee Formation."

4). Martin and Wells (1966, p. 33) described a section from the Berg Quarry, near Matson NE¼ sec. 8, T. 44 N., R. 2 E., Labadie 7½' Quadrangle, St. Charles County, Missouri, in which all but the lowermost member of the Joachim (Abernathy Member; not present in Missouri north of northern Perry County) are exposed (fig. 51). This section is 1 to 2 mi from the type sections of the Augusta, Boles, Defiance, and Matson Members of the Joachim Dolomite.

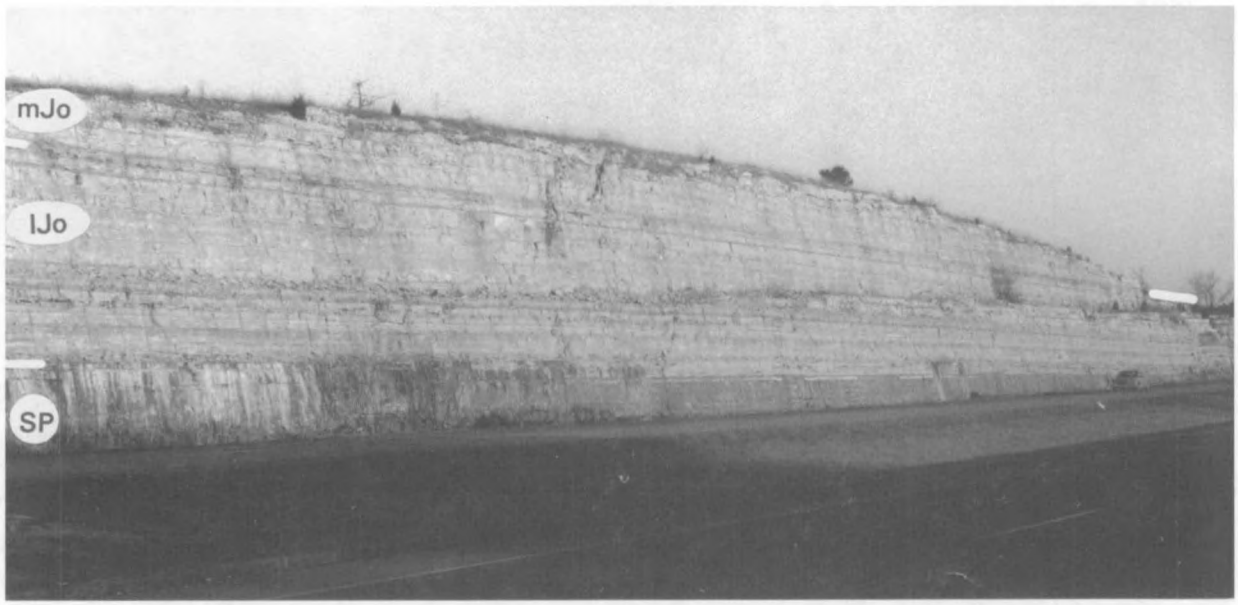


Figure 49 (A) ▲

Figure 49 (B) ▼

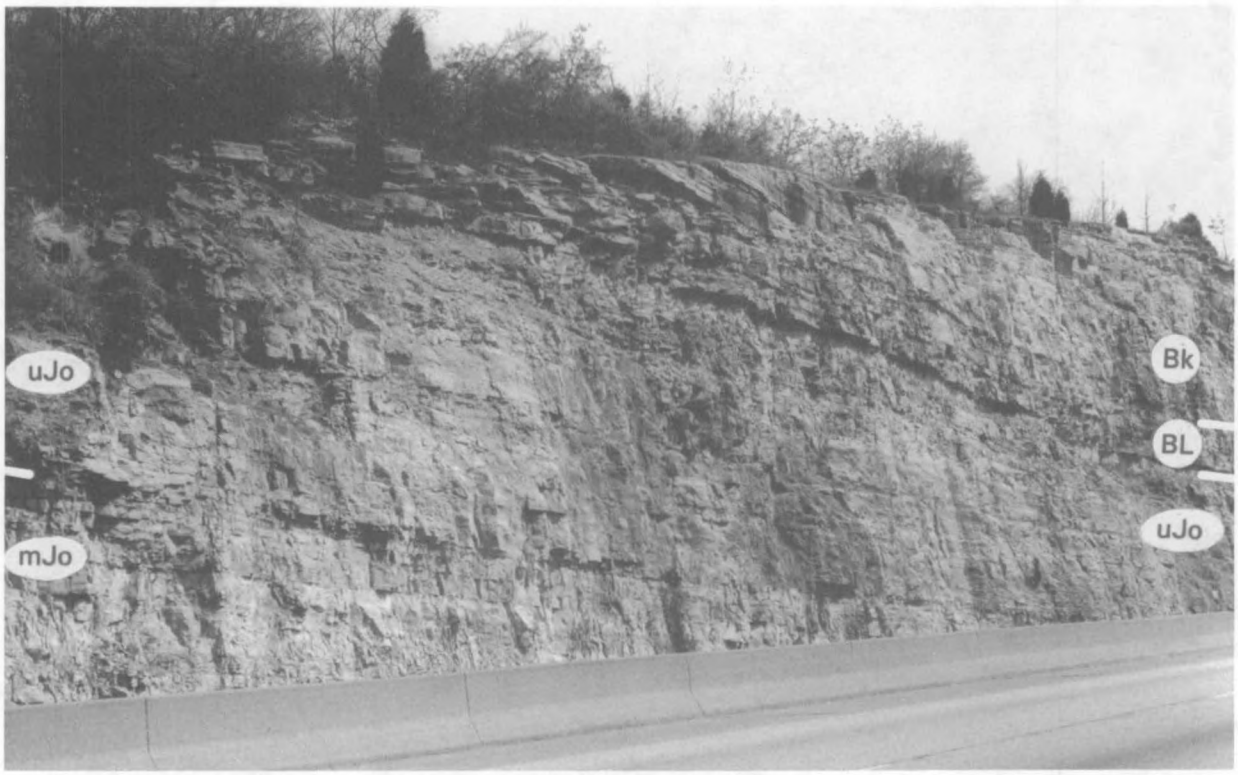


Figure 49. **Joachim Dolomite** *in eastern Missouri.* **(A) "Lower Joachim"** *(Augusta Member) and upper St. Peter Sandstone in a roadcut on I-55, immediately south of the bridge over Joachim Creek, Jefferson County.* **(B) "Middle Joachim"** *Boles and Defiance Members and "upper Joachim" Matson and Metz Members in a roadcut on I-44 east of Pacific Interchange; SE¼ SE¼ sec. 1, T. 43 N., R. 2 E., St. Louis County, Pacific 7½' Quadrangle.* **(SP)** *St. Peter Sandstone;* **(lJo)** *"lower Joachim Dolomite";* **(mJo)** *"middle Joachim Dolomite";* **(uJo)***"upper Joachim Dolomite";* **(Bk)** *Beckett Limestone;* **(BL)** *Bloomsdale Limestone. Photographs by T.L. Thompson.*

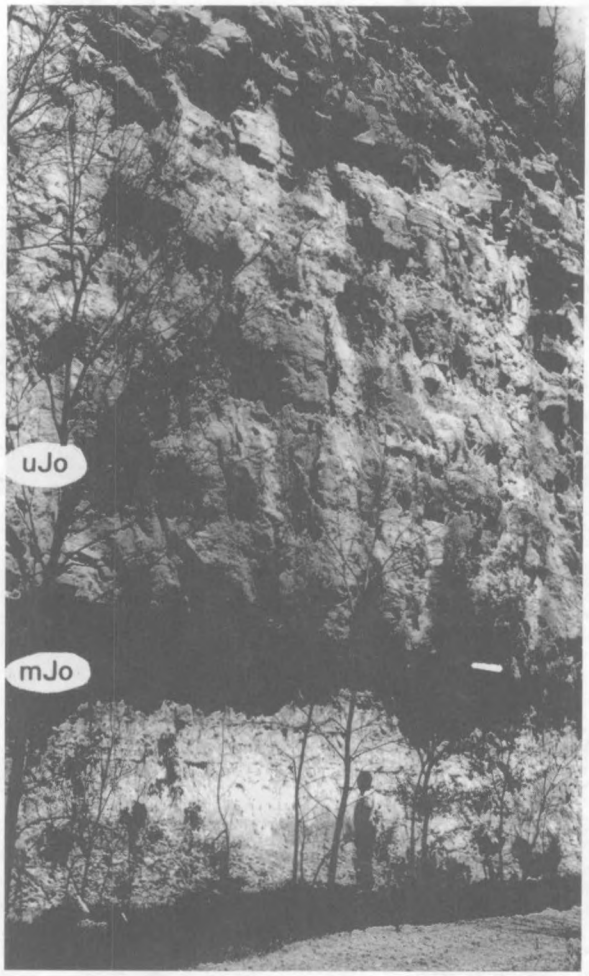
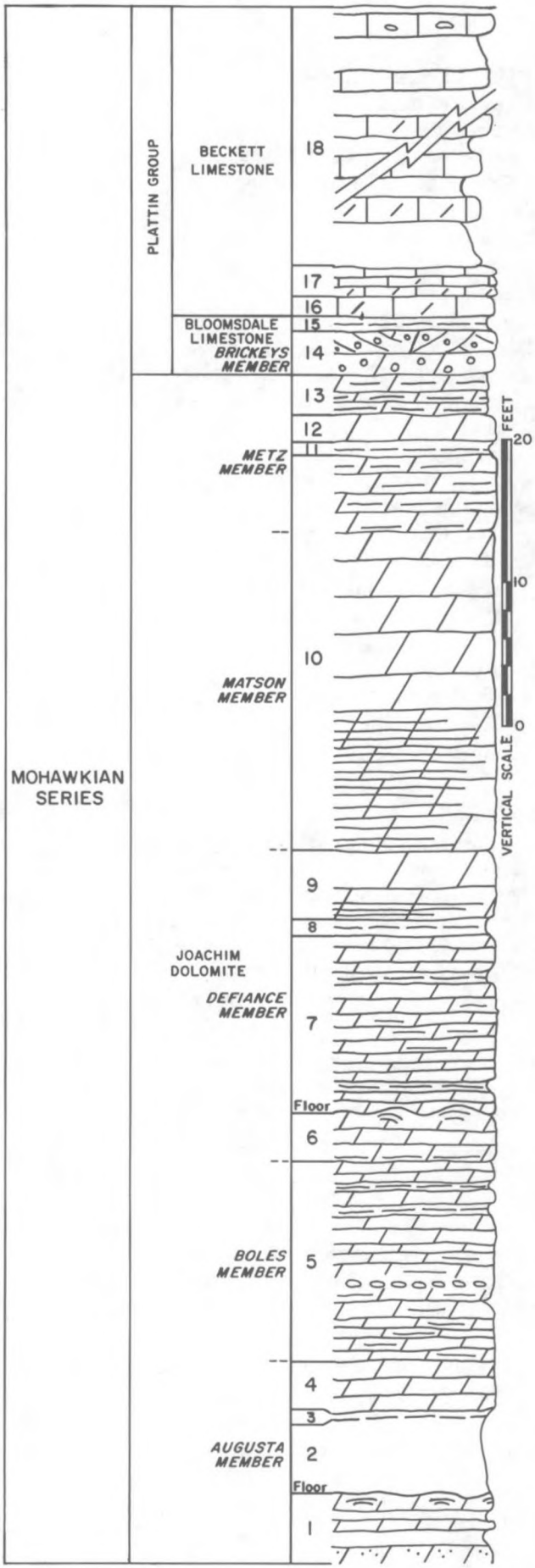


Figure 50. **Joachim Dolomite** *in an abandoned railroad cut immediately east of Glencoe, center NW¼ sec. 19, T. 44 N., R. 4 E., St. Louis County, Manchester 7½' Quadrangle.* **(mJo)** *"Middle Joachim Dolomite"; (**uJo**) "upper Joachim Dolomite." Photograph by T.L. Thompson.*

Other detailed sections of the Joachim Dolomite are located under the various members of the formation.

History of nomenclature

1855	Swallow	1st Magnesian Limestone
1891	Penrose	Izard limestone (lower part)
1894	**Winslow**	**Joachim dolomite (upper part; included Dutchtown)**
1895	Keyes	First Magnesian limestone (Folley limestone)
1900	Gallaher	4th Calciferous limestone
1902	Weeks	Joachim limestone ("Silurian")
1905	Van Horn and Buckley	Joachim formation (upper part)
	Bain and Ulrich (a, b)	Joachim limestone
1921	Dake	Joachim limestone of St. Peter group
1932	Keyes	Izard limestone (rejected "Joachim")
1934	Bassler and Kellett	Joachim limestone member of St. Peter sandstone (Buffalo River series)
1935	Edson	Jasper formation (in Arkansas)
1937	**McQueen**	**Joachim dolomite (restricted to present usage;** removed Dutchtown)
	Keyes (c)	Beloit limestone (lower part)
1945	Greene	Decorah and Plattin formations (lower part)
1948	Grohskopf	Rock Levee formation
		Joachim formation



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

PLATTIN GROUP

Beckett Limestone (23 ft 6 in.)

18. Limestone and dolomitic limestone, gray, gray-brown, pink mottled, fine-grained to dense; chert in some ledges; partially covered. (20 ft)
17. Dolomite, brown, thin-bedded; discontinuous fine-grained 3-in. calcarenite at base. (2 ft.)
16. Limestone, dolomitic in part, gray to yellow-brown, fine- to medium-grained. (1 ft 6 in.)

Bloomsdale Limestone

Establishment Shale Member (1 ft)

15. Shale, forms reentrant. (1 ft)

Brickeys Member (3 ft)

14. Dolomite and dolomitic limestone, yellow-brown, massive, oolitic; faintly cross-bedded in upper 2 ft. (3 ft).

Joachim Dolomite (81 ft)

Metz Member (9 ft 6 in,)

13. Dolomite, yellow-brown, argillaceous; thin to shaly bedding; forms reentrant. (2 ft)
12. Dolomite, yellow-brown, massive. (2 ft)
11. Shale, green. (6 in.)

10B. Dolomite, yellow-brown, medium-bedded with shale partings; minute vugs. (5 ft).

Matson Member (23 ft)

10A. Dolomite, yellow-brown to gray-brown, fine-grained, medium- to massive-bedded; laminated in lower 7.5 ft; fetid odor; minute vugs (pinpoint porosity). (23 ft)

Defiance Member (20 ft 6 in.)

9. Dolomite, gray, fine-grained to dense; massive unit but thinly laminated in lower part; blue-gray mottlings ("birdseye" structures). (4 ft 6 in.)
8. Shale, green; prominent on face. (6 in.)
7. Dolomite, gray, fine-grained, argillaceous, thin- to medium-bedded, blocky; pronounced interbedded green and tan shale (2-6 in.), and shale partings; penetration (?) mottlings. (12 ft)

MAIN QUARRY FLOOR

6. Dolomite, gray, fine-grained, argillaceous, medium-bedded; weathers yellow-brown; a few shale partings; breccia at base; hemispheroidal algae (stromatolitic) at top of unit. (3 ft 6 in.)

Boles Member (14 ft)

5. Dolomite, gray to red-brown, fine- to very fine-grained, argillaceous, thin- to medium-bedded; interbedded with green and gray shales and red-brown shale laminae; wavy surfaces; 1-in white chert band 5.5 ft above base. (14 ft)

Augusta Member (14 ft)

4. Dolomite, gray, fine-grained, medium-bedded; dark-gray mottling. (3 ft 6 in)
3. Shale, green. (6 in.)
2. Covered interval. (6 ft)

LOWER QUARRY FLOOR

1. Dolomite, gray-brown to yellow-brown, fine-grained; quartz sand grains; interbedded calcareous cemented sandstone; stromatolitic algae at top. (4 ft)

Figure 51. **Joachim Dolomite** *exposed in the Berg Quarry, NE¼ sec. 8, T. 44 N., R. 2 E., Labadie 7½' Quadrangle, St. Charles County, Missouri. Adapted from a description by Martin and Wells (1966).*

1951	Larson	Rock Levee formation
1961	Martin et al. (a)	Rock Levee formation Joachim formation
1963	Templeton and Willman	Joachim Dolomite (upper Ancell Group; **rejected "Rock Levee" of Grohskopf**) Metz Member Matson Member Defiance Member Boles Member Augusta Member Abernathy Member
1966	Martin and Wells	Joachim-Rock Levee Formations (lower part)
1976	Fraser	"strata equivalent to the Glenwood Formation in Missouri"
1982	Thompson	Joachim Dolomite
1983	Okhravi and Carozzi	Joachim Dolomite (3 members)
1991	**Thompson (present report)**	**Joachim Dolomite** **"upper Joachim Dolomite"** **Metz Member** **Matson Member** **"middle Joachim Dolomite"** **Defiance Member** **Boles Member** **"lower Joachim Dolomite"** **Augusta Member** **Abernathy Member**

Remarks -- Templeton and Willman (1963, p. 55) stated,

> "As originally defined, the Joachim Dolomite included the dolomite strata overlying the St. Peter Sandstone and underlying the Plattin Limestone. Strata in this position thicken greatly southward from Joachim Creek, and in southeastern Missouri McQueen (1937) differentiated the lower dark colored beds (which do not extend as far north as Joachim Creek) as the Dutchtown Formation and thus restricted the Joachim Formation to the upper beds. The overlying Pecatonica Formation also is absent in the type Joachim area, and in the nearby type Plattin area, but it separates Plattin and Joachim strata farther south."

In their description of the Joachim Dolomite in Missouri, Martin et al. (1961a, p. 26-27) stated,

> "The Joachim is predominantly a yellowish-brown, argillaceous dolomite which contains interbedded limestone and shale in its lower part. Scattered quartz sand grains are prominent in the lower beds of dolomite, shale, and limestone. Mud cracks are common. Chert is absent throughout the unit except for a thin but persistent, nodular chert bed at the top. Fossils are scarce in the Joachim in Missouri."

In the subsurface, the sequence of limestone and interbedded dolomite recognized above the "persistent, nodular chert bed" and below the base of the Plattin Group, which is consistently marked by an oolitic limestone and pebble conglomerate, has been identified in the past as the **Rock Levee Formation**. Thickest in Cape Girardeau County (up to 270 ft), the type section of the Rock Levee is (Grohskopf, 1948, p. 360) "...0.2 mile east of the junction of U.S. Highway 61 and Missouri Highway 74..." Cape Girardeau County, southeastern Missouri. The name is derived from a siding on the St. Louis-San Francisco Railway, in NW¼ NW¼ NW¼ sec. 24, T. 30 N., R. 13 E. This location is now that of the large, 400-ft-deep Southeast Missouri Stone Company quarry.

In the subsurface of east-central and northeastern Missouri, Rock Levee strata were identified as dolomite with thin limestone beds near the top, often with thin green and tan intercalated shale beds. However, the "persistent, nodular chert bed" is primarily a subsurface feature, and difficult if not impossible to identify in most surface exposures. Recent studies by the author of this report have concluded that, except in southeastern Missouri, where the "Rock Levee" comprises the "Pecatonica" and upper Joachim formations, the "Rock Levee" is a synonym of the upper part of the Joachim Dolomite. For this reason, **"Rock Levee" is no longer recognized as a formation**.

In southeastern Missouri, north of Perry County, the top of the Joachim Dolomite coincides with the base of the Plattin Group, at the base of the oolitic limestone and oolitic pebble conglomerate zone mentioned above (Brickeys Member of the Bloomsdale Limestone). South of Perry County, in Cape Girardeau and northern Scott counties, the upper part of the "Rock Levee" (mostly limestone with lesser amounts of dolomite, but below the oolitic limestone of the Brickeys Member of the Plattin Group) is identified as the **"Pecatonica Formation"**; the lower "Rock Levee" (mostly dolomite) is the **Joachim Dolomite**.

Templeton and Willman (1963, p. 57) demonstrated that in northern Missouri the Joachim Dolomite grades laterally northward into the Starved Rock Member of the St. Peter Sandstone. North of Perry County, the upper contact of the Joachim appears unconformable with the basal beds of the Plattin Group. In the region of the "Pecatonica," it may be conformable with the lower dolomitic portion of the "Pecatonica," and closely resembles the latter lithologically. In Scott, Cape Girardeau, and Perry counties, in southeastern Missouri, the Joachim conformably overlies the Dutchtown Formation. North of southern Perry County, the Dutchtown is absent, and the Joachim lies unconformably on the Tonti Member of the St. Peter Sandstone.

In Missouri, Joachim outcrops extend throughout the Mohawkian outcrop belt (fig. 33), but the formation pinches out in the subsurface westward and northwestward of Lincoln and Montgomery counties (fig. 52); this "pinch out" is associated with offlap on the Starved Rock bar that separated Joachim deposition from that of the Glenwood to the north and northwest. On figure 52, the Joachim in northwestern Missouri

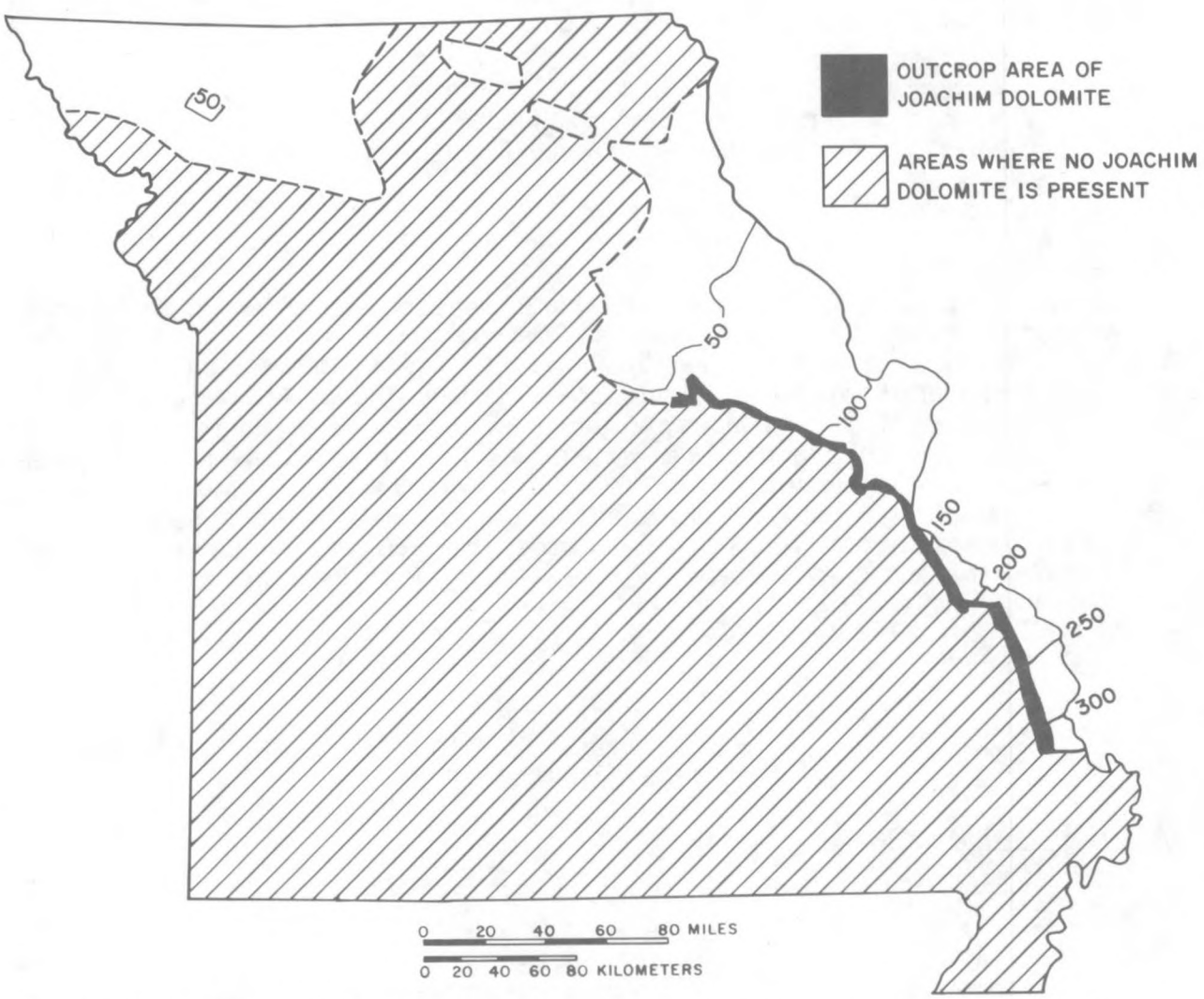


Figure 52. *Isopach map, distribution, and areas of outcrop of the* **Joachim Dolomite** *in Missouri. Isopach interval is 50 ft.*

represents the region of the **Glenwood Formation**. The Joachim varies from about 300 ft thick in Cape Girardeau County to less than 50 ft in Ralls and Montgomery counties.

In their analysis of the Joachim Dolomite, Templeton and Willman (1963, p. 58) stated,

> "Joachim sediments are characterized by mud-cracks, ripple-marks, rill-marks, rain drop impressions, undulatory scour surfaces, conglomeratic layers, and interbedding of thin strata of different lithology. These features suggest interrupted deposition in shallow water under fluctuating conditions. The presence of widely disseminated anhydrite and gypsum and of mud cracks with downturned edges... together with the general absence of a normal marine fauna, point toward accumulation in a barred basin that was subject to evaporation and periodic marine influxes.
>
> "It appears that much of the silt and sand in the Joachim Formation may have been winnowed out of the Starved Rock sands and carried seaward into the region of carbonate sedimentation. Sand was mixed with carbonate mud throughout this region in early Joachim time, and the sandstone at the top of the Abernathy Member appears to represent a thin but very widespread tongue of the Starved Rock Sandstone. In later Joachim time the admixture of sand was largely confined to the zone of contact with the Starved Rock Sandstone."

A recent paper by Okhravi and Carozzi (1983) described the depositional environment of the Joachim of southeastern Missouri as a sabkha (a salt flat or low salt marsh along the coastal area of desert regions; also spelled "sebkha"), which would fit the conditions mentioned above.

Templeton and Willman (1963, p. 56) differentiated six members of the Joachim Dolomite, based on "the content of shale, silt, and sand and differences in bedding." The six members and their major characteristics are the following:

Metz Member (thin bedded and silty)
***Matson Member** (thick bedded and relatively pure)
***Defiance Member** (thick bedded and silty)
***Boles Member** (thin bedded and shaly)
***Augusta Member** (thick bedded, silty)
***Abernathy Member** (sandy, with sandstone at top)
(* type section in Missouri)

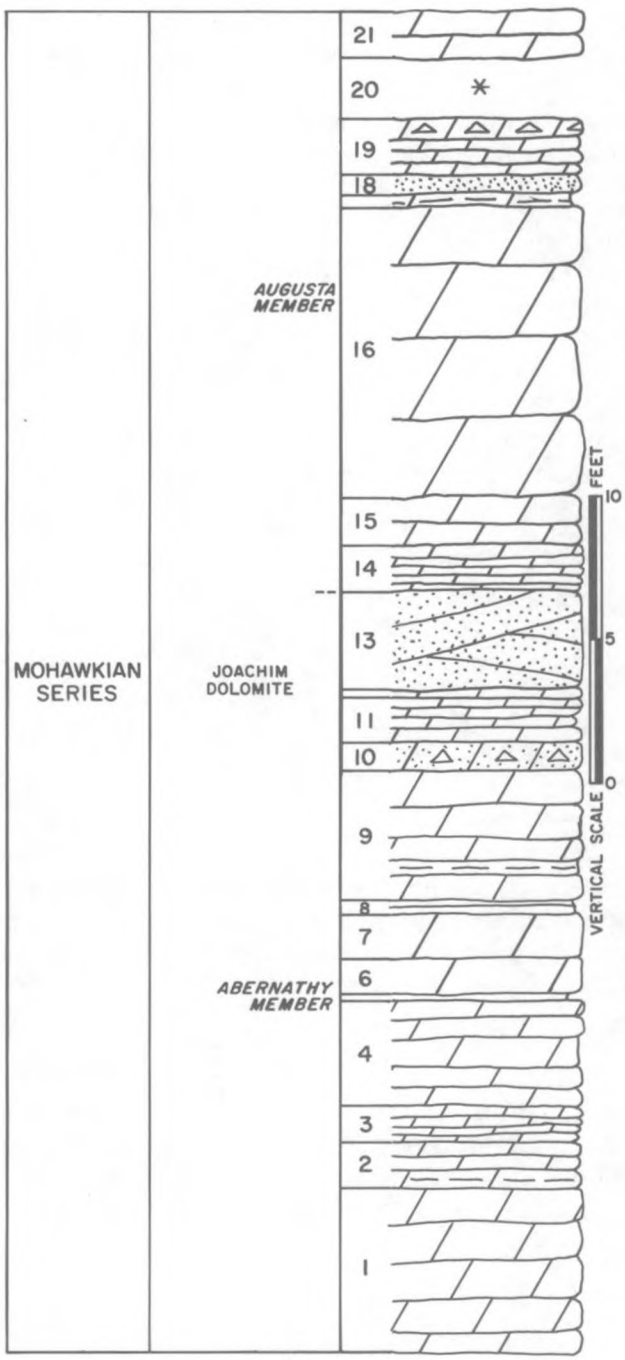
Following recent field studies, the present author has defined three informal divisions of the Joachim Dolomite, which are particularly usable in eastern and east-central Missouri, the type area for all but the Abernathy and Metz Members. The **"lower Joachim Dolomite"** consists of interbedded sandstone and dolomite and/or shale and dolomite (Abernathy and/or Augusta Members); the **"middle Joachim Dolomite"** is a silty, shaly dolomite (Boles and Defiance Members), usually forming a reentrant below the **"upper Joachim Dolomite,"** which comprises dense, more resistant dolomite beds of the Matson and Metz Members. The Matson and Metz are separable; the Defiance and Boles are more difficult to differentiate. The Abernathy Member occurs only in southeastern Missouri; the Augusta Member is the basal Joachim unit in eastern and east-central Missouri. The present uncertain status of the "Pecatonica" as a stratigraphic unit in Missouri may lead to assignment of the lower, alternating limestone and dolomite beds of the "Pecatonica" to the Joachim Dolomite.

"lower Joachim Dolomite"
(Abernathy and Augusta Members)

Abernathy Member of Joachim Dolomite
Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 58) "The Abernathy Member is composed mainly of silty, sandy, thick-bedded dolomite containing layers of dolomitic, medium-grained sandstone, a few beds of limestone, and some partings of dark red-brown shale. A small proportion of the dolomite is not sandy. At the top there is a distinctive and very persistent layer of St. Peter-type sandstone from 1½ to 14 ft thick, which forms an excellent key bed."

Type section -- Templeton and Willman (1963, p. 58) stated, "The Abernathy Member of the Joachim Formation is here named for the Abernathy school, 2 mi north of the type section in a bluff on the north side of Missouri State Highway 74, 1½ mi east of Dutchtown, Cape Girardeau County, Missouri." This exposure (figs. 46 and 53) is (p. 227) "half a mile west of Pecan Grove School and 1¾ mi east of Dutchtown, Cape Girardeau County, Missouri (SE NW SE 20 projected, 30N-13E, Cape Girardeau [and Gordonville 7½'] Quad.)."



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
Joachim Dolomite
Augusta Member (19 ft 8 in.)

21. Dolomite, light-gray, silty; faint carbonaceous streaks (1 ft 2 in.)
20. Covered interval. (2 ft)
19. Dolomite, light-gray, silty; thin to medium beds; conglomeratic at top; 1-in. shale at base forms reentrant. (1 ft 11 in.)
18. Dolomite, silty, sandy, very fine grained, massive. (9 in.)
17. Dolomite, dark-gray, very fine grained, argillaceous, platy. (4 in.)
16. Dolomite, light-buff, silty, thick-bedded; brown carbonaceous streaks; mud cracks 0.25 in. below top. (10 ft)
15. Dolomite, silty, massive; calcite-filled vugs in lower part. (1 ft 7 in.)
14. Dolomite, light-gray, silty; thin, regular beds. (1 ft 11 in.)

Abernathy Member (22 ft 6 in.)

13. Sandstone, light-brown, fine- to medium-grained, dolomite-cemented, massive, slightly cross-bedded. (3 ft 7 in.)
12. Shale, gray. (0-1 in.)
11. Dolomite, silty, thin-bedded. (1 ft 9 in.)
10. Dolomite, sandy, conglomeratic. (10 in.)
9. Dolomite, silty; massive, except 0.5 in. shale 1 ft 7 in. above base. (4 ft 2 in.)
8. Dolomite, dark-brown, argillaceous; brown shale partings; top of bench. (5 in.)
7. Dolomite, silty, massive. (1 ft 9 in.)
6. Dolomite, laminated, massive. (1 ft)
5. Dolomite, argillaceous, silty, platy. (2 in.)
4. Dolomite, silty, laminated. (3 ft 3 in.)
3. Dolomite, slightly silty, finely vuggy; thin to medium beds. (1 ft 3 in.)
2. Dolomite, silty, laminated; 1 in. shaly dolomite at base and 6 in. above. (1 ft 8 in.)
1. Dolomite, light-gray, silty, weakly laminated, massive; base concealed. (5 ft 8 in.)

"The basal 2 feet of the Abernathy (light gray silty dolomite) overlies 1 foot of the Dutchtown Formation (dark gray limestone) just above the road at the west edge of the exposure, but is on the upthrown side of a fault." (Templeton and Willman, 1963, p. 227)

Figure 53. *Type section of the* **Abernathy Member of the Joachim Dolomite**, *a bluff north of Highway 74, east of Dutchtown, SE¼ NW¼ SE¼ sec. 20, T. 30 N., R. 13 E. (projected), Cape Girardeau County, Missouri (fig. 46). Adapted from a description by Templeton and Willman (1963).*

History of nomenclature

1948	Grohskopf	Joachim formation (part)
1961	Martin et al. (a)	Joachim formation (part)
1963	**Templeton and Willman**	**Abernathy Member of Joachim Dolomite**
1975	Willman and Buschbach	Abernathy Member of Joachim Dolomite
1991	**Thompson (present report)**	**Abernathy Member of Joachim Dolomite "lower Joachim Dolomite" (lower part)**

Remarks--Templeton and Willman (1963, p. 58) identified the Abernathy Member, interbedded dolomite and sandstone, of the Joachim Dolomite as the basal unit of McQueen's "middle division" of the Joachim (McQueen, 1939, p. 65-66). They added (p. 58-59),

> "The Abernathy Member normally is much lighter colored, less argillaceous, and more silty and sandy than the underlying Dutchtown Formation. It is more sandy than the overlying Augusta Member, contains a coarser grade of sand (chiefly medium grains instead of very fine to fine grains), and usually contains a greater number of shale partings, although it cannot be considered a shaly unit. As a rule the Abernathy also contains a higher proportion of dark brown dolomite or limestone than the Augusta. Chert is common just beneath the topmost sandstone of the Abernathy Member in wells in Jackson County, Illinois, and occurs at several lower horizons. No fossils have been found."

The Abernathy Member, which is absent north of Perry County, Missouri, was measured by Templeton and Willman to be 60 ft thick near Perryville, and 95 ft thick near Grand Tower, Jackson County, Illinois. Templeton and Willman (1963, p. 59) stated,

> "The Abernathy Member is believed to grade westward into Starved Rock Sandstone along Apple Creek, Cape Girardeau and Perry Counties, Missouri, the transition taking place first in the lower Abernathy strata...In the southern outcrop belt and adjacent parts of western Illinois the Abernathy Member is thought to thin out northward between Augusta beds and the Tonti Member of the St. Peter, because the Starved Rock Sandstone, as well as the Abernathy, is missing from most of that area."

Augusta Member of Joachim Dolomite

Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 59) "The Augusta Member consists principally of pure to silty, thick-bedded dolomite and limestone. It lacks the sandstone beds and disseminated medium sand grains of the underlying Abernathy Member and generally has fewer shale layers. Ordinarily it is distinctly thicker bedded and less shaly than the overlying Boles Member. However, the lower part of the member contains green shale layers up to 16 inches thick in exposures along Missouri State Highway 25, in Ste. Genevieve County..."

Type section -- Templeton and Willman (1963, p. 59) stated, "The Augusta Member of the Joachim Formation is here named for the village of Augusta, which is 5 miles west of the type section [St. Albans West Section, p. 227-228] in a cut on the Chicago, Rock Island and Pacific Railroad, at the foot of the bluffs along the southeast side of the Missouri River, a mile southwest of the hamlet of St. Albans, Franklin County, Missouri." (SW¼ NE¼ SW¼ sec. 10, T. 44 N., R. 2 E., Labadie 7½' Quadrangle; figs. 54, 55, and 57A).

History of nomenclature

1948	Grohskopf	Joachim formation (part)
1961	Martin et al. (a)	Joachim formation (upper part)
1963	**Templeton and Willman**	**Augusta Member of Joachim Dolomite**
1975	Willman and Buschbach	Augusta Member of Joachim Dolomite
1991	**Thompson (present report)**	**Augusta Member of Joachim Dolomite "lower Joachim Dolomite" (upper part)**

Remarks--Although the Augusta Member of the Joachim Dolomite is mostly alternating beds of dolomite and dolomitic shale, Templeton and Willman (1963, p. 59) added,

> "In the southern outcrop area the lower part of the Augusta also contains several beds of both Glenwood-type sandstone and more or less dolomitic St. Peter-type sandstone. The sandstone beds are particularly prominent in the type area in the Missouri Valley. The layers of shale, siltstone, and Glenwood-type sandstone grade rapidly eastward and southward into dolomite.

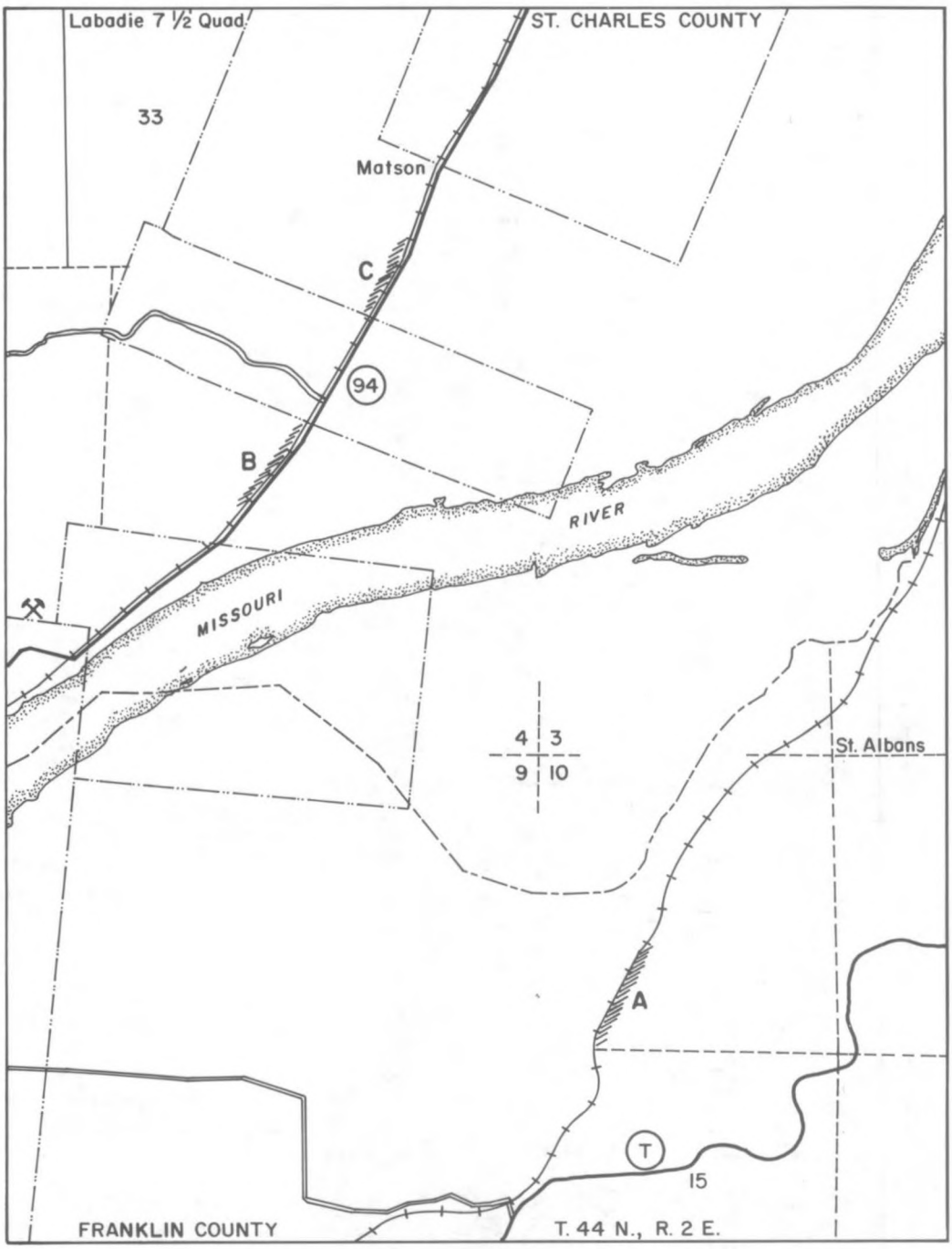
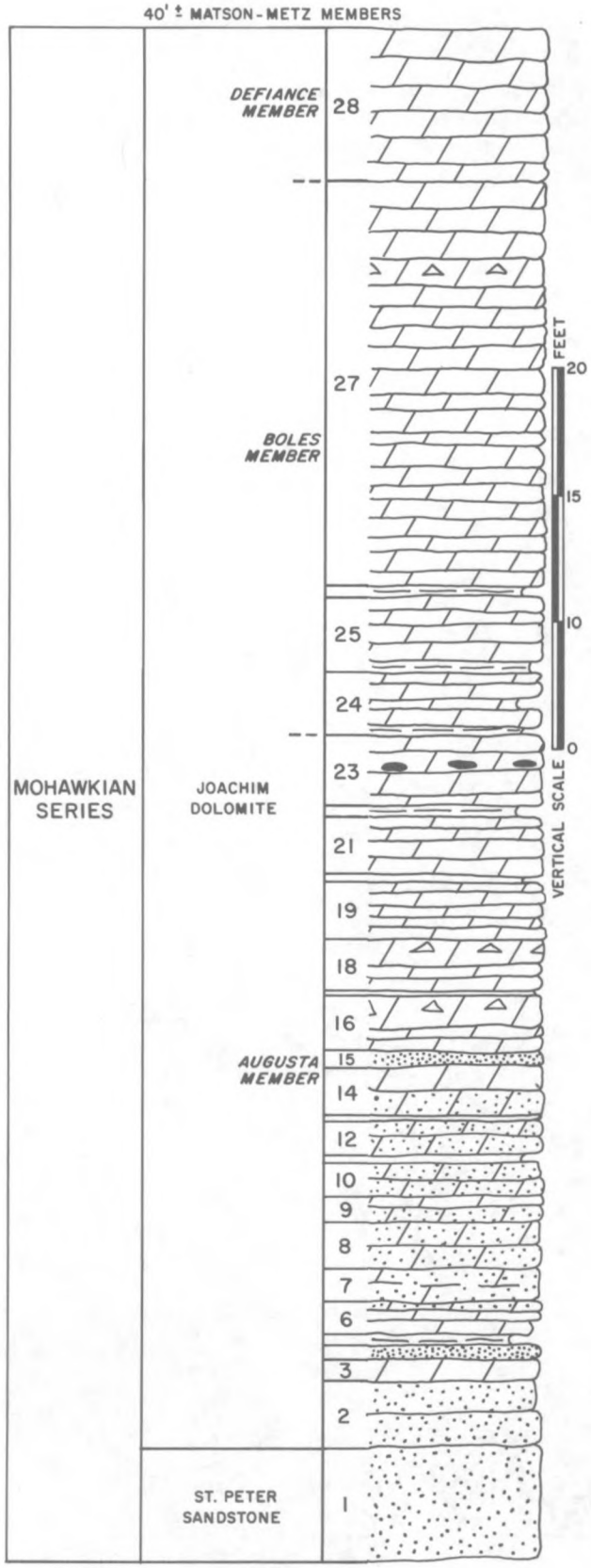


Figure 54. *Part of the Labadie 7½' Quadrangle, showing the locations of the type sections of the* **(A) Augusta, (B) Boles** *and* **Defiance,** *and* **(C) Matson Members** *of the* **Joachim Dolomite** *("lower" and "middle Joachim"), Franklin and St. Charles counties, east-central Missouri.*



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Joachim Dolomite

Matson-Metz Members (40 ft ±)

Defiance Member (5 ft 6 in.)

28. Dolomite, white weathering, silty, massive; contains brown argillaceous laminae; shale parting at base makes most prominent break in face. (5 ft 6 in.)

Boles Member (20 ft 2 in.)

27. Dolomite, pure; thin to medium beds; interlayered with silty dolomite (40%); abundant dark-brown and dark-gray argillaceous laminae; 1 ft conglomeratic dolomite with black pebbles 2 ft 9 in. below top. (15 ft)
26. Shale, green, yellow mottling; scour surface at base (persistent marker bed). (4 in.)
25. Dolomite, pure to silty, vuggy, massive to dense; middle 2 in. weathers white. (2 ft 1 in.)
24. Dolomite, pure to silty, vuggy; 4-in to 1-ft beds interbedded with thin 1-2-in. green to greenish-gray shale. (2 ft 9 in.)

Augusta Member (28 ft 10 in.)

23. Dolomite, upper half silty; middle 1 ft pure; lower 4 in. silty; medium-bedded; calcite-filled vugs to porous; shale parting in middle; locally has chert lenses. (2 ft 8 in.)
22. Shale and argillaceous dolomite. (5 in.)
21. Dolomite, silty; medium beds with shale partings. (2 ft 2 in.)
20. Shale, greenish gray; scour surface at base. (3 in.)
19. Dolomite, white, silty, dense, thin-bedded. (2 ft 3 in.)
18. Dolomite, pure, coarse to silty; conglomeratic at top; lower 1 ft thinly interbedded with brown shale. (2 ft)
17. Sandstone, dolomite cement. (1-2 in.)
16. Dolomite, conglomeratic, silty, algal domes upper 1 ft 2 in.; thin-bedded to massive lower 1 ft. (2 ft 2 in.)
15. Sandstone, bimodal; interbedded with green shale. (7 in.)
14. Dolomite, white, dense; upper 1 ft massive; lower 1 ft 2 in. sandy. (2 ft 2 in.)
13. Shale, brown; white sandy streaks. (3 in.)
12. Dolomite, silty, very sandy, massive. (1 ft 10 in.)
11. Shale, brown, sandy. (3 in.)
10. Dolomite, buff, silty, sandy. (1 ft 9 in.)
9. Sandstone, bimodal; brownish-green shale partings upper 6 in.; medium grained, silty, dolomitic lower 1 ft. (1 ft 6 in.)
8. Dolomite, gray-brown, silty, sandy, massive. (1 ft 10 in.)
7. Sandstone, coarse; dolomite cement. (1 ft 2 in.)
6. Dolomite, massive, thin-bedded; silty to sandy upper 5 in. (1 ft 4 in.)
5. Shale, sandy; makes reentrant. (5 in.)
4. Sandstone, yellow, massive. (8 in.)
3. Dolomite, massive. (6 in. - 1 ft)
2. Sandstone, gray, bimodal; scour surface at top. (2 ft 7 in.)

St. Peter Sandstone (4 ft 6 in.)

1. Sandstone, fine; green clay streaks at top; base concealed. (4 ft 6 in.)

Figure 55. *Type section of the* **Augusta Member of the Joachim Dolomite,** *an exposure on the Chicago, Rock Island, and Pacific Railroad, SW¼ NE¼ SW¼ sec. 10, T. 44 N., R. 2 E., Labadie 7½' Quadrangle, Franklin County, Missouri (fig. 54). Adapted from a description by Templeton and Willman (1963, p. 227-228).*

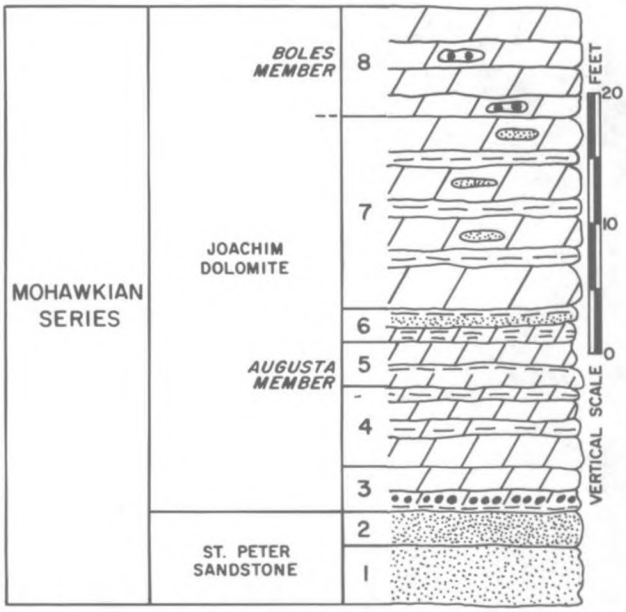


Figure 56. **Augusta Member of the Joachim Dolomite** *exposed in a roadcut on I-55, Perry County, southeastern Missouri, NE¼ NE¼ NE¼ sec.13 (projected), T. 36 N., R. 9 E., Lithium 7½' Quadrangle, mileage 139.5. Adapted from a description by Thacker and Satterfield (1977).*

ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
Joachim Dolomite
Boles Member (9 ft)
8. Dolomite, finely crystalline; thinner bedded than underlying unit; conglomerate stringers common in some beds; mud cracks on top surface; locally fucoidal. (9 ft)

Augusta Member (31 ft)
7. Dolomite, blue-gray, finely crystalline; weathers light brown, massive beds separated by 1-3 in.-thick shale beds; fucoidal; thin sand stringers and sandy dolomite layers throughout. (16 ft)
6. Dolomite, finely crystalline, massively bedded; planar stromatolites capped by conglomerate at base; upper half sandy dolomite; capped by thin shale bed overlying a 3-in. bed of sandstone. (1 ft)
5. Dolomite, finely crystalline, massively bedded, fucoidal; 3-in. shale seam in middle of unit; upper surface undulating. (4 ft)
4. Dolomite, finely crystalline; thin argillaceous beds alternating with massive beds; few thin shale stringers. (6 ft)
3. Dolomite, finely crystalline, upper 3 in. calcarenitic; thin conglomerate stringers throughout; thin shale bed at base. (4 ft)

St. Peter Sandstone
2. Sandstone, iron stained to yellow-orange, massively bedded, fine- to medium-grained; grains rounded and frosted and poorly sorted; contains sandstone pebbles in base. (2 ft 6 in - 3 ft)
1. Sandstone, white, fine- to medium-grained, massively bedded; weathers brown-yellow; grains rounded and frosted and fairly well-sorted; draped appearance due to sloughing off of outer layers of sand; sandstone pebbles in top. (5 ft 3 in - 7 ft 6 in)

"Two layers of pure, brown, algal dolomite or limestone, separated by 4 to 6 feet of silty gray dolomite, are distinctive features of the upper part of the Augusta Member...In some places these pure layers are massive, but in others they exhibit thin to medium beds. Locally both layers are conglomeratic.

"A nodular chert band occurs 1 foot 3 inches below the top of the member...west of St. Albans, Franklin County, Missouri...and chert is common in the member in wells in southwestern Illinois."

In Perry and Ste. Genevieve counties (fig. 56), Missouri, the Augusta Member is 60 to 71 ft thick. It is approximately 30 ft thick at the type section, in Franklin County, east-central Missouri.

"middle Joachim Dolomite"
(Boles and Defiance Members)

Boles Member of Joachim Dolomite
Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 60) "The Boles Member consists principally of thin to medium beds of silty, dense dolomite alternating with similar layers of pure, vuggy dolomite. In the Cape Girardeau section, however, the member is limestone. Closely spaced films, partings, and layers of dark red-brown to gray-green shale, as much as 5 inches thick but usually thinner, are a characteristic feature."

Type section -- Templeton and Willman (1963, p. 60) stated, "The Boles Member of the Joachim Formation is here named for the hamlet of Boles, which is on the Missouri Pacific Railroad on the south side of the Missouri River and 6 miles southwest of the type section, a quarry in the bluffs on the north side of the river 1 mile southwest of Matson, St. Charles County, Missouri." This section, in the northeast corner of the SE¼ NE¼ SW¼ sec. 4, T. 44 N., R. 2 E., Labadie 7½' Quadrangle (figs. 54, 57B, and 58), is about

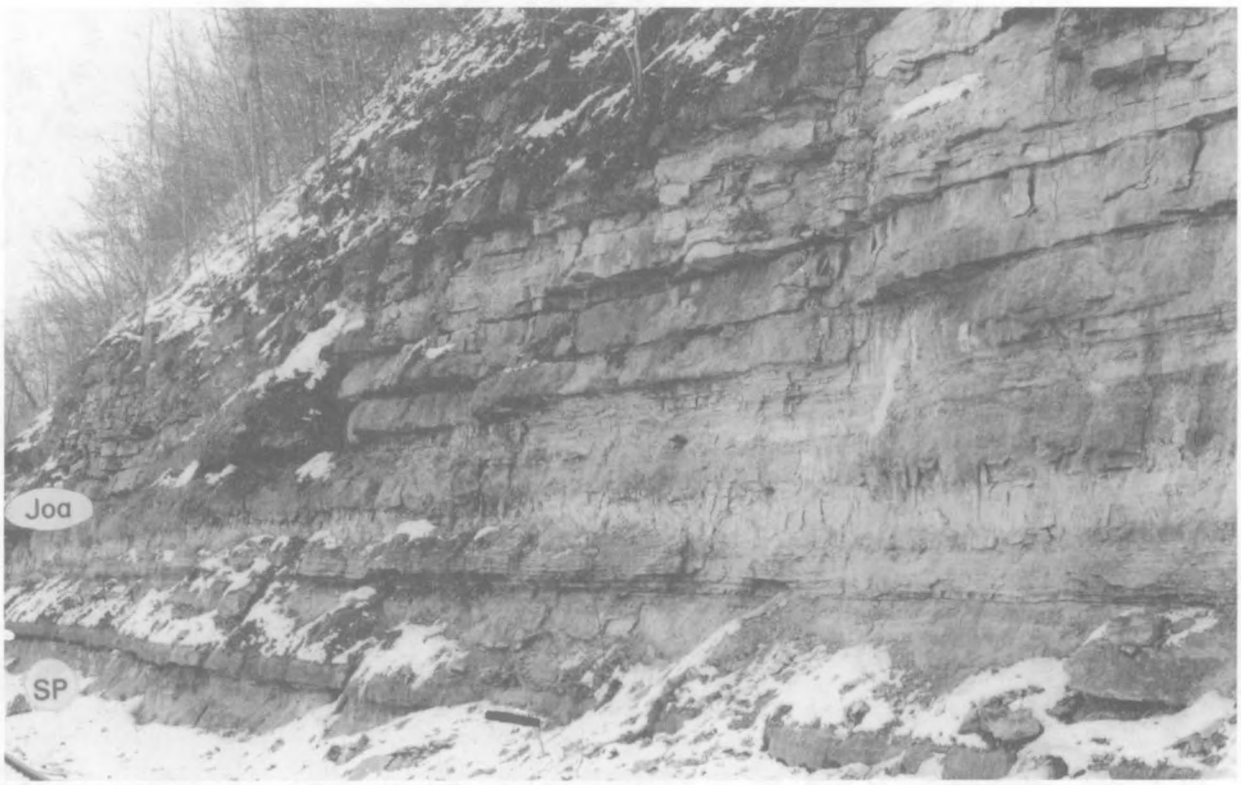


Figure 57 (A)▲ Figure 57 (B)▼

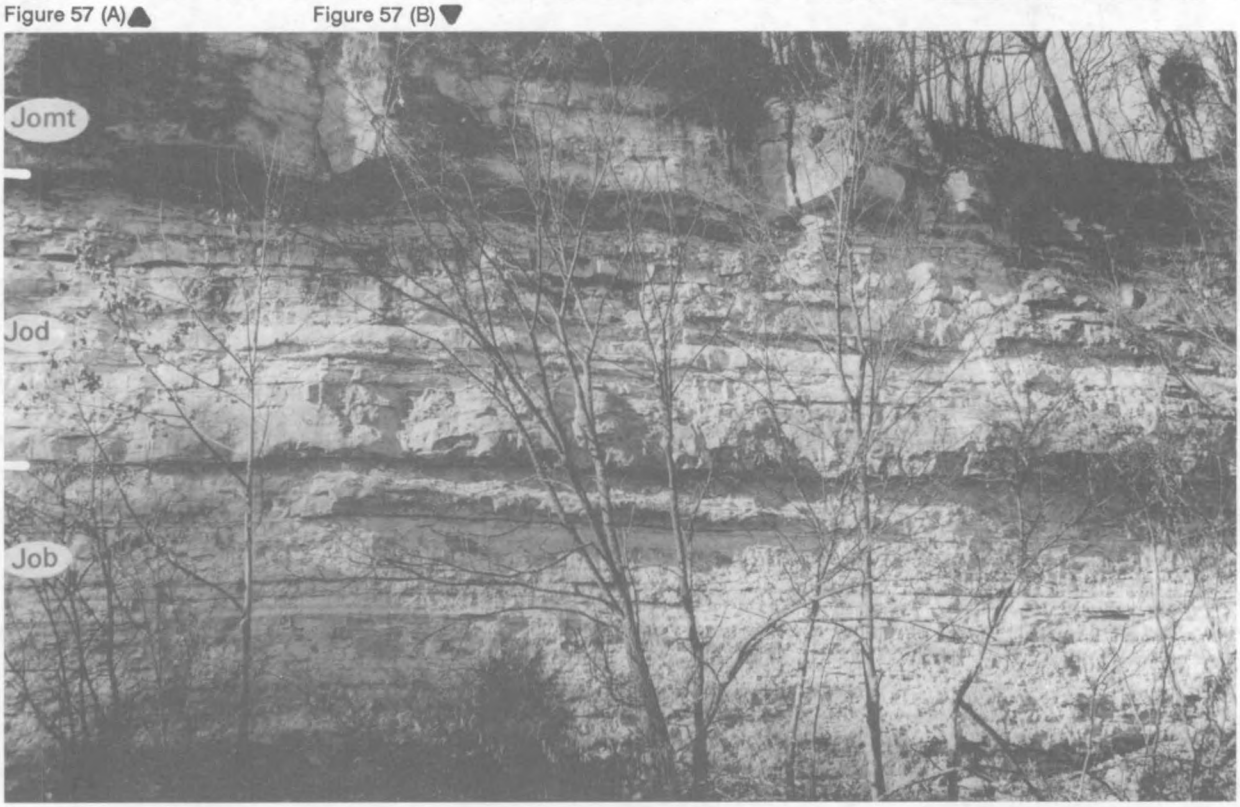
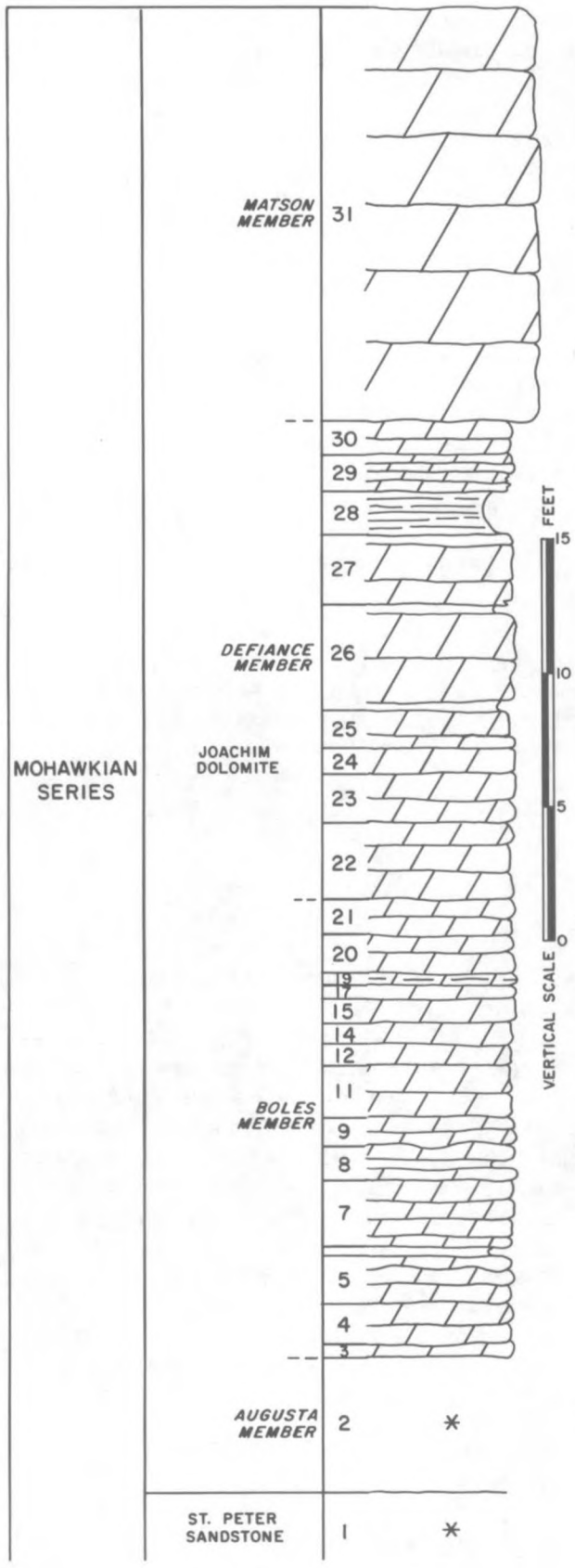


Figure 57. *"Lower" and "middle"* **Joachim Dolomite**. **(A)** *Type section of the* **Augusta Member** *(fig. 55), SW¼NE¼SW¼ sec. 10, T. 44 N., R. 2 E., Franklin County.* **(SP)** *St. Peter Sandstone;* **(Joa) Augusta Member**. *Photograph by T.L. Thompson.* **(B)** *Type section of the* **Boles** *and* **Defiance Members** *(fig. 58), SE¼ NE¼ SW¼ sec. 4, T. 44 N., R. 2 E., St. Charles County.* **(Job)** *Boles Member;* **(Jod)** *Defiance Member;* **(Jomt)** *Matson Member. Photograph by Myrna Rueff.*



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Joachim Dolomite

Matson Member (15 ft)

31. Dolomite, brown, pure, laminated. (15 ft)

Defiance Member (18 ft 3 in.)

30. Dolomite, light-buff, silty; 2 beds. (1 ft 1 in.)
29. Dolomite, silty, thin-bedded; argillaceous at base. (1 ft 2 in.)
28. Shale, green to buff. (1 ft 10 in.)
27. Dolomite, argillaceous; lower 2.5 ft massive. (3 ft)
26. Dolomite, silty, massive; weathers white, smooth face; gray-green shale top and bottom: irregular 2-6 in. thick at top; 5 in. thick at bottom. (4 ft 3 in.)
25. Dolomite, brown; argillaceous laminae in lower 7 in; like no. 26. (1 ft 5 in.)
24. Dolomite, pure, finely porous, weakly laminated, massive. (10 in.)
23. Dolomite, dark-brown; argillaceous laminae; like no. 24. (2 ft)
22. Dolomite; weakly laminated; brown shale parting and scour surface at base; like no. 24. (2 ft 8 in.)

Boles Member (17 ft 7 in.)

21. Dolomite, silty, thin- to medium-bedded; wavy brown shale partings. (1 ft 10 in.)
20. Dolomite, silty, massive, burrowed. (1 ft 8 in.)
19. Dolomite, silty; upper 2 in. shaly; lower 7 in. massive; dark-gray penetration marks. (9 in.)
18. Shale, dark-greenish-gray. (2 in.)
17. Dolomite, silty, massive. (8 in.)
16. Shale, gray-green. (1 in.)
15. Dolomite, silty, massive; dark shale laminae. (1 ft 2 in.)
14. Dolomite, pure, vuggy; calcite-filled vugs. (10 in.)
13. Shale, greenish-gray. (2 in.)
12. Dolomite, laminated, massive. (10 in.)
11. Dolomite; shale partings. (2 ft)
10. Shale, greenish-gray. (2 in.)
9. Dolomite; shale partings; scour surface at base. (1 ft 1 in.)
8. Dolomite and shale interbedded. (1 ft 1 in.)
7. Dolomite, silty; in 4-9-in. beds with shale partings; lenses of pure, porous dolomite. (2 ft 6 in.)
6. Shale, dark-greenish-gray; weathers yellow; broadly undulating scour surface at base (marker bed). (4 in.)
5. Dolomite, pure, vuggy, massive; wavy shale partings 5 in. below top. (1 ft 8 in.)
4. Dolomite; silty, massive; upper 10 in. argillaceous; lower 7 in. pure. (1 ft 5 in.)
3. Dolomite, silty; overlies pure dolomite (no. 2) (base concealed by slump). (6 in.)

Augusta Member

2. Dolomite and shale (concealed by slump). (8 ft 4 in.)

St. Peter Sandstone

1. Sandstone, concealed. (20 ft).

Figure 58. *Type section of the* **Boles** *and* **Defiance Members of the Joachim Dolomite** *("middle Joachim Dolomite"), SE¼ NE¼ SW¼ sec. 4, T. 44 N., R. 2 E., St. Charles County, Missouri (figs. 54 and 57). Adapted from a description by Templeton and Willman (1963, p. 228).*

2 mi west of and almost directly across the Missouri River Valley from the type section for the Augusta Member, and is also the type section for the overlying Defiance Member of the Joachim Dolomite.

History of nomenclature

1948	Grohskopf	Rock Levee formation (lower part)
1961	Martin et al. (a)	Rock Levee formation (lower part)
1963	**Templeton and Willman**	**Boles Member of Joachim Dolomite**
1975	Willman and Buschbach	Boles Member of Joachim Dolomite
1991	**Thompson (present report)**	**Boles Member of Joachim Dolomite "middle Joachim Dolomite" (lower part)**

Remarks -- The Boles Member of the Joachim Dolomite has been identified in eastern Missouri, from Cape Girardeau to St. Louis and St. Charles counties. The Boles is 15 to 30 ft thick but averages about 20 ft in most outcrops; it is thickest in Cape Girardeau County. The author of the present report finds Boles and Defiance rocks very similar in appearance (silty, shaly dolomites), and therefore difficult to distinguish. Lumping the two together into the "middle Joachim" forms a unit distinct from the overlying massive algal dolomite of the Matson Member (figs. 49B, 50, and 51) and one that also can usually be separated from the underlying shaly Augusta Member.

Templeton and Willman (1963, p. 61) stated that seven discontinuous bands of nodular white to black chert occur in the Boles, and that the uppermost band serves as the Joachim-Rock Levee boundary (Grohskopf, 1948). They added,

> "The Boles Member may be distinguished from adjacent members by its thin bedding, high shale content, and the usual presence of one or more chert bands, although no chert is present in the Ancell type section at Cape Girardeau...The numerous shale partings make the member especially conspicuous in a fresh face, such as is found in a quarry 1½ miles southeast of Perryville, Perry County, Missouri..."

Defiance Member of Joachim Dolomite

Templeton and Willman (1963)

Original description -- (Templeton and Willman, 1963, p. 61) "The Defiance Member is composed mostly of silty, party [sic] argillaceous, thick-bedded dolomite that has a smooth, white, weathered face. The basal unit, however, consists of only slightly silty, thick-bedded to massive dolomite from 4½ to 15 feet thick (generally from 5 to 10 feet thick) that has a rougher and browner face than the rest of the member...Although the Defiance Member contains several beds of gray-green shale in the type area, including one 18- and 24-inch bed about 2 feet below the top, most of the shale grades southward into argillaceous, silty dolomite before reaching the exposure at Glencoe, St. Louis County...The shale layers probably represent the outer margin of the contact facies with the Starved Rock Sandstone Member of the St. Peter. The argillaceous dolomite associated with the shale is characteristically mottled and streaked with dark, carbonaceous, pyritic material. A little chert occurs in the lower part of the Defiance in wells in Jackson County, northwestern Illinois, and a nodular band of white chert is present 8½ feet above the base of the member and 4 feet below the top of a quarry which is above and about 1/8-mile northeast of the highway cut near Bloomsdale, Missouri...In the Ancell type section, the Defiance Member consists of silty dolomite and limestone interbedded with pure limestone...The limestone facies seems chiefly confined to the Cape Girardeau area. Except for occasional algal domes...fossils have not been observed in the Defiance Member."

Type section -- Templeton and Willman (1963, p. 228) described the type section of the Defiance Member (the same as that for the Boles Member) as a "Quarry in the north bluffs of the Missouri Valley, one mile southwest of the village of Matson, St. Charles County, Missouri (NE cor. SE NE SW 4, 44N-2E, Augusta Quad.)." This section is on the Labadie 7½' Quadrangle, and is described under "Type section" of the **Boles Member** (figs. 54, 57B, and 58).

Reference sections -- Two excellent exposures of the Boles and Defiance Members of the Joachim Dolomite are in St. Louis County, east-central Missouri, Pacific 7½' Quadrangle: 1) a roadcut on the north side of I-44, immediately east of the interchange at Pacific, NE¼ NW¼ sec. 12 and SE¼ SE¼ sec. 1, T. 43 N., R. 2 E., including "middle" and "upper Joachim" and lower Plattin Group (fig. 49B); and 2) a roadcut on Highway W, 1 mi south of Eureka, SW¼ SE¼ sec. 1, T. 43 N., R. 3 E., including "middle" and "upper Joachim," Plattin Group, Decorah Group, and "lower Kimmswick Limestone" (see description under **Decorah Group**, fig. 109).

History of nomenclature

1948	Grohskopf	Rock Levee formation (part)
1961	Martin et al. (a)	Rock Levee formation (part)
1963	**Templeton and Willman**	**Defiance Member of Joachim Dolomite**
1975	Willman and Buschbach	Defiance Member of Joachim Dolomite
1991	**Thompson (present report)**	**Defiance Member of Joachim Dolomite "middle Joachim Dolomite" (upper part)**

Remarks -- The Defiance Member of the Joachim Dolomite varies from 20.5 ft thick in the type area of the formation, to 40 ft at Cape Girardeau. The thickest section measured is 58 ft, in Ste. Genevieve County, but faulting may have exaggerated the thickness.

As stated in the discussion of the Boles Member of the Joachim Dolomite, the Boles and Defiance Members are not always readily separable; together, however, they constitute an identifiable "middle Joachim" unit.

"upper Joachim Dolomite"
(Matson and Metz Members)

Matson Member of Joachim Dolomite
Templeton and Willman (1963)

Original description -- (Templeton and Willman, 1963, p. 61-62) "The Matson Member consists mainly of relatively pure, gray to light brown, laminated, thick-bedded algal dolomite that grades southward into dark brown limestone having the same features...Purity, massiveness, and relatively strong resistance to weathering distinguish the Matson from any other member of the Joachim...but in the St. Louis region it was confused with the Pecatonica Formation, which is similar in many respects but is absent in that region.

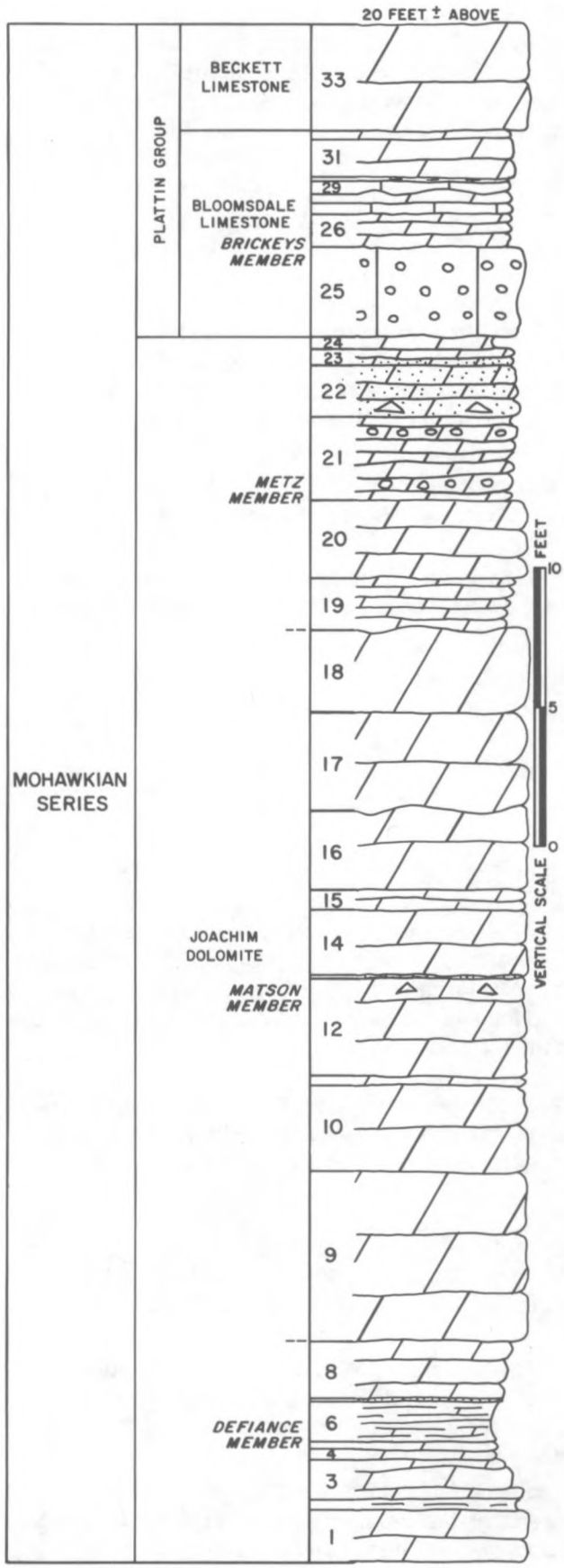
"In the dolomite facies, the Matson has a weathered face that is darker and rougher than that of the adjacent members...Chert has not been observed in the Matson Member."

Type section -- Templeton and Willman (1963, p. 228) described the type section of the Matson Member as a "Quarry and bluff exposure in north bluff of Missouri Valley, half a mile west of the village of Matson, St. Charles County, Missouri (NE NE NE 4 projected, 44N-2E, Augusta Quad.)." This section is on the Labadie 7½' Quadrangle (figs. 54, 59, and 60).

Reference sections -- The Matson and Metz Members of the Joachim Dolomite, along with the overlying Plattin Group, are well exposed in roadcuts on I-44, in western St. Louis County (fig. 49B), SE¼ SE¼ sec. 1, T. 43 N., R. 2 E., Pacific 7½' Quadrangle, and on Missouri Highway 30 near Weber Hill (fig. 68) in Jefferson County (see details under **Plattin Group**).

Another excellent exposure of the Matson Member of the Joachim Dolomite is an abandoned Missouri Pacific railroad cut just east of Glencoe, St. Louis County, east-central Missouri, SE¼ NW¼ NW¼ sec. 19, T. 44 N., R. 4 E., Manchester 7½' Quadrangle. At this section (fig. 50), the Joachim is represented by 13.5 ft of Defiance, 21.5 ft of Matson, and 16 ft of Metz.

Another readily accessible section of both the Matson and Metz Members of the Joachim Dolomite is in a roadcut at the Lewis Road Exit to I-44, immediately east of the Meramec River bridge (figs. 61 and 62), center W½ SW¼ sec. 33, T. 44 N., R. 4 E., St. Louis County, Manchester 7½' Quadrangle.



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

PLATTIN GROUP

Beckett Limestone

33. Limestone, light-gray, finely crystalline, burrowed.

Bloomsdale Limestone

Establishment Shale Member (2 in)

32. Dolomite, shaly. (2 in.)

Brickeys Member (8 ft 10 in.)

31. Dolomite, buff, very silty, chalky, massive. (1 ft 3 in.)
30. Shale, dolomitic. (2 in.)
29. Limestone, brown, pure, lithographic, conglomeratic, massive. (7 in.)
28. Dolomite, very argillaceous; scour surface at top and bottom. (5 in.)
27. Limestone; like no. 29. (5 in.)
26. Dolomite, light-brown, argillaceous, massive; dark-brown carbonaceous mottling. (1 ft 6 in.)
25. Limestone, light-brown, dolomitic, very finely oolitic, massive. (3 ft 6 in.)

Joachim Dolomite

Metz Member (11 ft)

24. Dolomite, greenish-gray, argillaceous, shaly; forms reentrant. (5 in.)
23. Dolomite, brownish-gray, silty, medium-bedded. (1 ft)
22. Dolomite, sandy, conglomeratic, massive; fragments of dense, brown dolomite. (1 ft 10 in.)
21. Dolomite, very silty, thin-bedded; thin oolitic streaks. (2 ft 7 in.)
20. Dolomite, pure, massive; laminated at base. (2 ft 9 in.)
19. Dolomite, very argillaceous, silty. (1 ft 5 in.)

Matson Member (30 ft)

18. Dolomite, pure, massive; prominent 8-in. scour surface at top. (3 ft)
17. Dolomite, dense, argillaceous, thick-bedded; lenses and beds of porous, pure dolomite. (4 ft 3 in.)
16. Dolomite, pure, gray, vuggy; dense silty mottled areas; scour surface on top. (3 ft 1 in.)
15. Dolomite; interbedded silty and pure. (9 in.)
14. Dolomite, light-gray, silty; small burrows upper 7 in. (2 ft 5 in.)
13. Shale, green, sandy. (0-1 in.)
12. Dolomite, pure, laminated, massive; silty lenses; upper 1 ft 2 in. conglomeratic. (4 ft 2 in.)
11. Dolomite, argillaceous; weathers white. (6 in.)
10. Dolomite, slightly argillaceous, dense; smooth face. (3 ft 9 in.)
9. Dolomite, pure, vuggy, laminated, very massive. (7 ft 9 in.)

Defiance Member (8 ft 4 in.)

8. Dolomite, argillaceous, medium-bedded; gray and yellow mottling. (2 ft 1 in.)
7. Dolomite, very argillaceous. (3 in.)
6. Shale, gray-green, dolomitic; layers of argillaceous dolomite. (1 ft 6 in.)
5. Dolomite, very argillaceous. (6 in.)
4. Dolomite; dark-brown argillaceous laminations. (5 in.)
3. Dolomite, silty, thin- to thick-bedded; dark-gray carbonaceous flecks and penetration mottling. (1 ft 9 in.)
2. Shale; interbedded with argillaceous dolomite. (5 in.)
1. Dolomite, argillaceous; zones of dark-gray flecks; base concealed. (2 ft)

Figure 59. *Type section of the* **Matson Member of the Joachim Dolomite,** *NE¼ NE¼ NE¼ sec. 4, T. 44 N., R. 2 E., St. Charles County, Missouri (fig. 54). Adapted from a description by Templeton and Willman (1963, p. 228).*

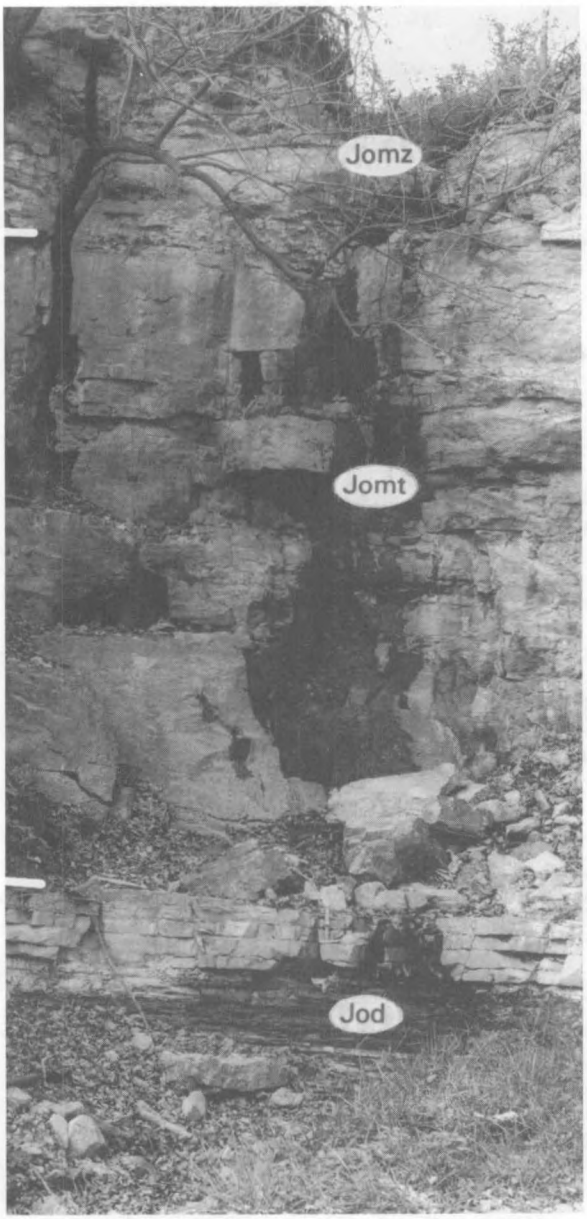


Figure 60. *Type section of the* **Matson Member of Joachim Dolomite,** *NE¼ NE¼ NE¼ sec. 4, T. 44 N., R. 2 E., St. Charles County, east-central Missouri (fig. 59).* (**Jomt**) *Matson Member;* (**Jomz**) *Metz Member;* (**Jod**) *Defiance Member. Photograph by T.L. Thompson.*

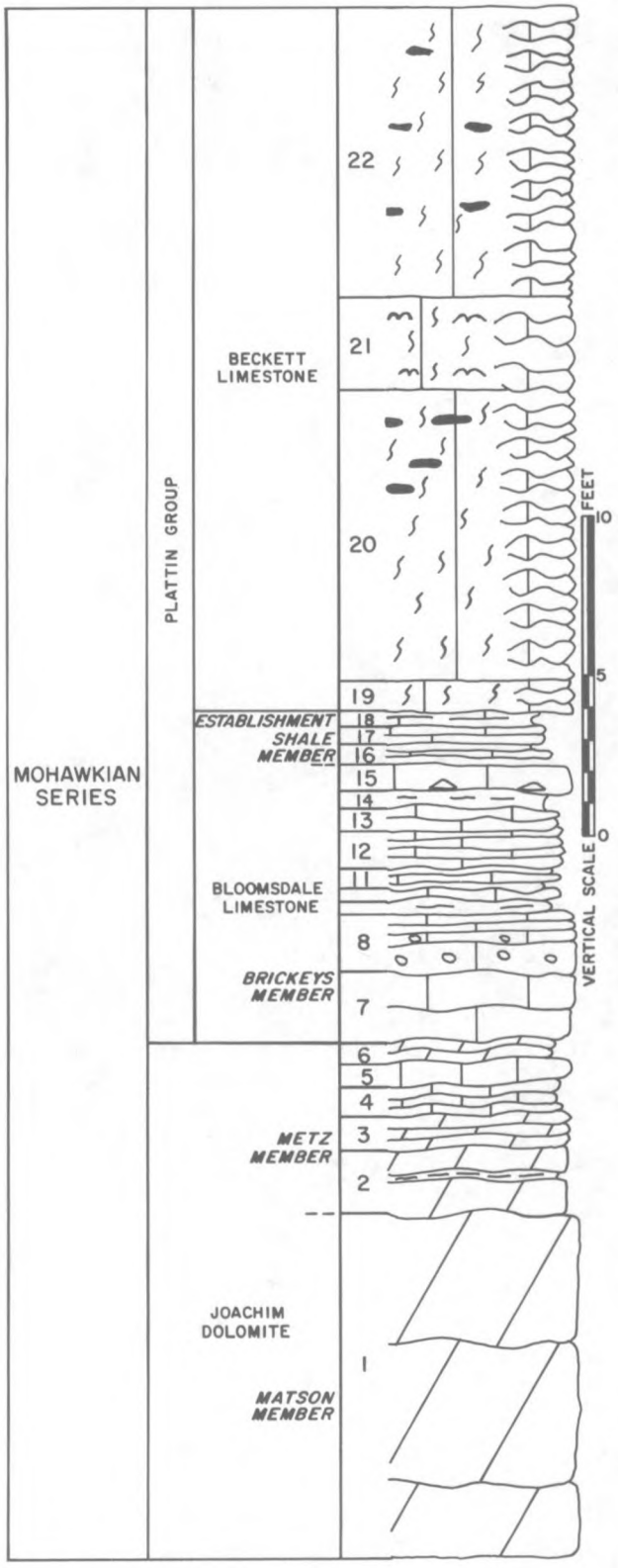
The following is a description of a section of the Matson Member in a roadcut on I-55, W½ NW¼ sec. 19, T. 41 N., R. 6 E., Jefferson County, Herculaneum 7½' Quadrangle (see fig. 69):

> Dolomite, brown, lithographic, massive 4-6 ft beds; with laminae or thin 1-2-in. incipient irregular bedding; some limestone lenses and beds. Calcite blebs and nodules scattered throughout. (35 ft)

History of nomenclature

1948	Grohskopf	Rock Levee formation (part)
1961	Martin et al. (a)	Rock Levee formation (part)
1963	**Templeton and Willman**	**Matson Member of Joachim Dolomite**
1975	Willman and Buschbach	Matson Member of Joachim Dolomite
1991	**Thompson (present report)**	**Matson Member of Joachim Dolomite "upper Joachim Dolomite" (lower part)**

Remarks -- In east-central Missouri, the Matson Member is the most resistant member of the Joachim Dolomite. It is typically a dark-brown, dense, algal dolomite, in beds 3 to 4 ft thick, that weathers with a



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
PLATTIN GROUP
Beckett Limestone (22-25 ft)

22. Limestone, like no. 20; to top of outcrop. (8-10 ft)
21. Limestone, gray to brown, slightly dolomitic, argillaceous, coarsely burrowed; weathers coarsely pitted. (3 ft)
20. Limestone, light-gray, sublithographic, heavily burrowed (0.25-0.5 in.); very hackly 0.5-1 in. beds; scattered brown chert in upper third. (10 ft)
19. Limestone, light-gray, lithographic; prominent vertical burrows; not as hackly as above. (1 ft)

Bloomsdale Limestone
Establishment Shale Member (1 ft 1 in. - 1 ft 10 in.)

18. Shale and argillaceous limestone, gray-green; hackly bedding; very fossiliferous. (4 in.)
17. Limestone, gray, argillaceous; "birdseye" structures; very irregular. (4-10 in.)
16. Shale, gray-green, blocky; two irregular 1-2-in. brown argillaceous limestone beds in middle; very irregular base; top contact with no. 17 hackly. (5-7 in.)

Brickeys Member (8 ft)

15. Limestone, light-gray, argillaceous; pebble conglomerate in upper half; base wavy, irregular; single bed. (8-10 in.)
14. Shale, greenish-gray; upper 1-2 in. fissile, lower 3-4 in. blocky; base wavy. (4-6 in.)
13. Limestone, brown, finely crystalline; upper 2 in. irregular, wavy bedded. (8 in.)
12. Limestone, gray, argillaceous; prominent "birdseye" structures; single bed that weathers to even 3-4 in. beds. (1 ft 3 in.)
11. Shale and limestone; two shale beds with limestone (like no. 10) between them; upper shale blocky (1-4 in.); middle limestone very nodular and irregular (0-3 in.); lower shale fissile (1-3 in.). (4-6 in.)
10. Limestone, dark-gray, argillaceous; very irregular beds. (2-4 in.)
9. Shale, gray-green, platy to fissile. (2 in.)
8. Limestone, brown, sublithographic, partly oolitic; very fossiliferous; basal bed 1 ft thick; upper beds 4-6 in. thick; top at base of 2-in.-thick shale. (2 ft 2 in.)
7. Limestone, light-gray, very finely crystalline to sublithographic; no oolites; bedding irregular; very irregular base; two 1-ft limestone beds with 1-2 in. shale between. (2 ft 2 in.)

Joachim Dolomite (19 ft 6 in. - 20 ft)
Metz Member (7 ft 6 in.)

6. Dolomite, buff, laminated; "birdseye" structures; bedding irregular; top irregular. (1 ft)
5. Limestone, light-gray, sublithographic; single irregular nodular bed; "Plattin-like." (6-8 in.)
4. Limestone, light-gray, laminated; base very irregular; weathers to hackly, incipient 0.5 in. beds. (1 ft)
3. Dolomite, light-gray, dense; "birdseye" structures prominent as dark gray spots; large 1-2 in. calcite-filled vugs; very irregular bedding, top very irregular; weathers tan. (1 ft 6 in.-2 ft)
2. Dolomite, light-yellow-brown, argillaceous; red brown "birdseye" structures; 2 beds with 2-in. shale 8-10 in. below top. (2 ft 6 in.)

Matson Member (12 ft)

1. Dolomite, tan to brown, laminated to "vuggy"; laminated part tan and finely crystalline; vuggy part darker brown and coarser grained; irregular discontinuous bedding; irregular algal structures weather out (lower roadcut on exit ramp). (12 ft)

Base of exposure at I-44 level.

Figure 61. **Matson** *and* **Metz Members of the Joachim Dolomite** *and the lower part of the* **Plattin Group**, *exposed in roadcuts at the Lewis Road exit to I-44, St. Louis County, east-central Missouri, center W½ SW¼ sec. 33, T. 44 N., R. 4 E., Manchester 7½' Quadrangle. Adapted from a field description by T.L. Thompson, 1986.*

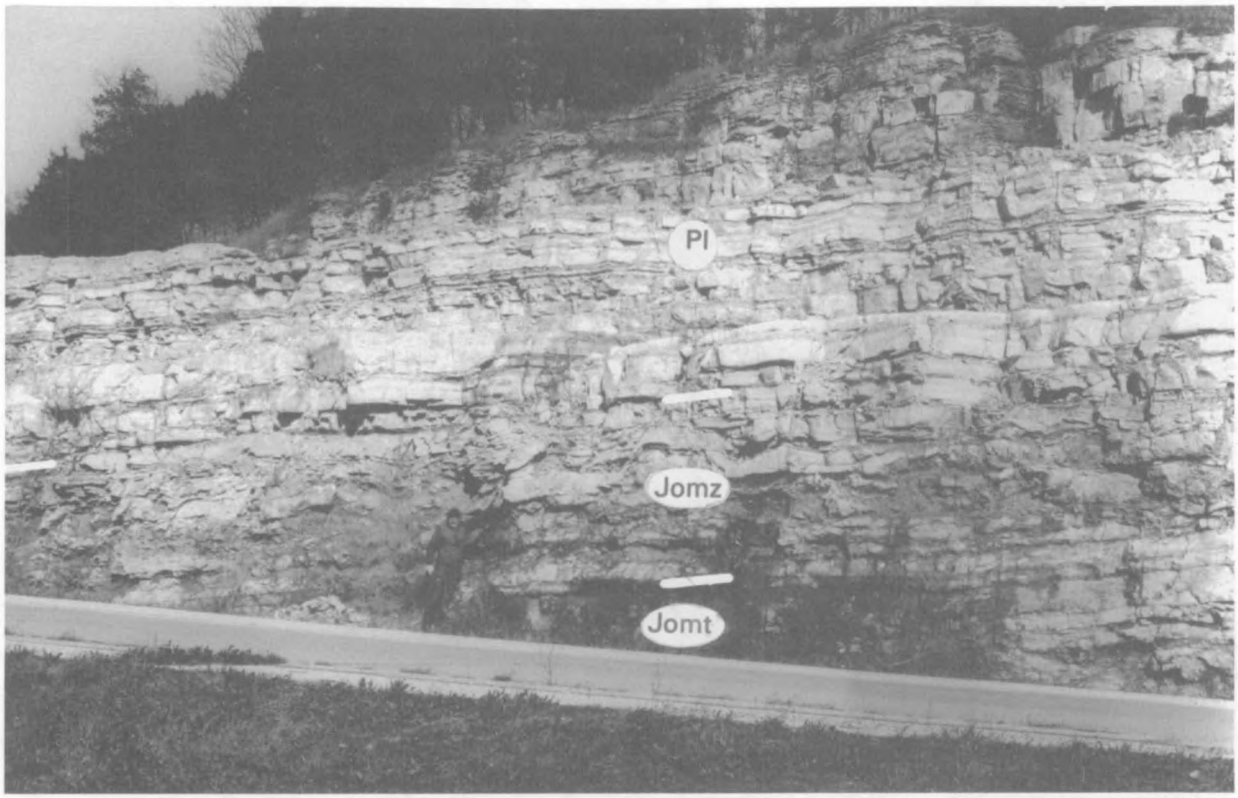


Figure 62. **Matson** *and* **Metz Members of the Joachim Dolomite** *("upper Joachim") and lower* **Plattin Group** *at the Lewis Road exit to I-44, center W½ SW¼ sec. 33, T. 44 N., R. 4 E., St. Louis County, Missouri (fig. 61).* **(Jomt)** *Matson Member;* **(Jomz)** *Metz Member;* **(Pl)** *Plattin Group. Photograph by T.L. Thompson.*

distinctive pitted surface. When broken with a hammer, the fresh surface gives off a strong petroliferous odor. The Matson forms resistant ledges protruding beyond the less resistant, underlying Defiance Member, and also appears more resistant than the overlying, thinner-bedded Metz Member.

According to Templeton and Willman (1963, p. 62),

> "Ostracodes are abundant in several beds in the basal 5½ feet of the Matson Member at the exposure north of Hillsboro, and are present in a thin-bedded reentrant about 10 feet below the top of the bluff that constitutes the eastern end of the Ancell type section. Algal domes as much as 3 feet in diameter and 2 feet high occur 13½ feet below the top of the bluff. The marine fauna referred to under *Joachim Formation* is found in 7 feet of dolomitic limestone, which constitutes the basal unit of the Matson Member, in a ravine just north of the village of Zell, Ste. Genevieve County, Missouri."

Metz Member of Joachim Dolomite

Templeton and Willman (1963)

Original description -- (Templeton and Willman, 1963, p. 62) "The Metz Member consists chiefly of silty, thin- to medium-bedded dolomite but contains subordinate beds of pure dolomite. In the Cape Girardeau area and adjacent parts of Illinois the member grades wholly or partly to silty limestone. Relatively thin units composed of argillaceous, silty, moderately shaly, thin-bedded dolomite or limestone generally are present at the top and bottom of the member. These argillaceous units range from 1½ to 23 feet thick and in places exhibit prominent mud-cracks on the bedding surfaces. A 6-inch bed of moderately silty oolitic dolomite occurs about 1 foot 9 inches below the top of the Metz Member in Ste. Genevieve County, Missouri. Scour surfaces having a relief of as much as 12 inches are common within the member. No chert has been observed and, with the exception of a few algal domes,no fossils have been found."

Type section -- Templeton and Willman (1963, p. 62) described the type section as "a quarry just north of West Point Creek and Landing, Calhoun County, Illinois," and stated the member was named from "Metz Lake on the floodplain of the Mississippi River, 5 miles north of the type locality..." This section was further described as (p. 228) "Quarry in east bluff of Mississippi River, and exposures in bluff north of quarry, a quarter of a mile north of West Point Landing, Calhoun County, Illinois (SE NE SE 19, 7N-2W, Hardin [Foley 7½'] Quad.)." This quarry contains the type section of both the Metz Member of the Joachim Dolomite and the Victory Member of the Hager Limestone of the Plattin Group (Grand Detour Formation of Templeton and Willman, 1963).

Reference sections -- Templeton and Willman (1963, p. 62) stated, "The Metz Member crops out in a cut on the north side of Missouri State Highway 30 between House Springs and Cedar Hill, Jefferson County, Missouri (NE NW SE 18, 42N-4E, Hillsboro Quad.)..." Discussed in more detail under **Bloomsdale Limestone**, this section was measured by the author of the present report as follows (fig. 71):

Plattin Group (97 ft)
- Beckett Limestone (81 ft)
- Bloomsdale Limestone (16 ft)
  - Establishment Shale Member (3 ft)
  - Brickeys Member (13 ft)

Joachim Dolomite (27 ft 6 in.)
- Metz Member (11 ft)
- Matson Member (16 ft 6 in.)

The Metz Member of the Joachim Dolomite is well exposed in roadcuts at the Lewis Road exit of I-44, immediately east of the bridge over the Meramec River, center W½ SW¼ sec. 33, T. 44 N., R. 4 E., St. Louis County, Manchester 7½' Quadrangle. Strata of the Matson Member of the Joachim Dolomite to the lower part of the Beckett Limestone of the Plattin Group are exposed (figs. 61 and 62). Another excellent exposure of both members is in roadcuts on Missouri Highway 30 near Weber Hill, Jefferson County (fig. 68).

Metz and Matson Members of the Joachim Dolomite are also well exposed in a roadcut on I-55, in east-central Jefferson County (see **Plattin Group**, figs. 69 and 70A), W½ NW¼ sec. 19, T. 41 N., R. 6 E., Herculaneum 7½' Quadrangle. Above 35 ft of the Matson Member in this roadcut, is the following succession:

> Interbedded dark-gray to brownish-gray, massively bedded stromatolitic dolomite, bluish-gray lithographic dolomite, and silty laminated dolomite (70 percent silty dolomite, 15 percent lithographic dolomite, 10 percent stromatolitic dolomite); top of unit in wavy contact with overlying Brickeys Member of Bloomsdale Limestone. Two 2-in. bluish-black shale beds in upper 6 ft. (12 ft)

History of nomenclature

1948	Grohskopf	Rock Levee formation (upper part)
1961	Martin et al. (a)	Rock Levee formation (upper part)
1963	**Templeton and Willman**	**Metz Member of Joachim Dolomite**
1975	Willman and Buschbach	Metz Member of Joachim Dolomite
1991	**Thompson (present report)**	**Metz Member of Joachim Dolomite "upper Joachim Dolomite" (upper part)**

Remarks -- In east-central Missouri, the Metz Member of the Joachim Dolomite is readily distinguished from the underlying Matson Member, because it is less resistant and is composed of yellow-brown shaly laminated dolomite, with prominent "birdseye" structures, a lithology that occurs as minor beds in the Matson but constitutes most of the Metz. The overlying Brickeys Member of the Bloomsdale Limestone is distinctive in being a chocolate brown oolitic lithographic limestone and interbedded dolomite. The upper contact is disconformable; a wavy contact is usually readily identifiable.

Templeton and Willman (1963, p. 62-63) stated,

> "Southward from Perry County, Missouri and Jackson County, Illinois, the Metz Member is overlain by the Pecatonica Formation. The abrupt lithologic change suggests the presence of a minor diastem, but no evidence of unconformity has been found. North of Perry and Jackson Counties the Pecatonica Formation

and the basal Blomeyer Member of the succeeding Mifflin Formation wedge out, so that the Brickeys Member of the Mifflin rests directly upon Metz strata. As neither Metz nor Brickeys beds are missing in the area and neither show important variations in thickness, this hiatus apparently was not accompanied by erosion. However, a significant break in sedimentation is suggested by the common presence of a combined scour and solution surface at the top of the Metz. This surface is well exhibited in the quarry east of Glencoe, Missouri...where it has an undulatory relief of 6 inches and is pitted and ferruginous."

"Platteville Group"

Bain, 1905; Templeton and Willman, 1963

Original description -- (Bain, 1905, p. 18-19) "The beds included under this name have long been known in this district as the Trenton limestone. Since it is now believed that they are not the exact equivalents of the Trenton in its type locality, it is proposed to use a local name for them...The beds are largely made up of nonmagnesian limestone. In the lower portion are certain magnesian beds which are distinguished from the dolomites of the Galena by their earthy appearance. The Platteville limestone ordinarily has a total thickness of 60 feet, while extremes in thickness run from 40 to nearly 75 feet.

"A generalized section of the Platteville includes the following beds:

	Feet
4. Thin beds of limestone and shale	10-20
3. Thin-bedded brittle limestone, breaking with a conchoidal fracture	25-30
2. Buff to blue magnesian limestone, heavy bedded, frequently a dolomite	20-25
1. Shale, blue	1-5"

Type section -- Templeton and Willman (1963, p. 63) stated, "Because Bain designated no specific type section, Kay (1931, p. 369, 371) proposed as the type a ravine exposure west of Platteville [Wisconsin] (SW NW NW 20, 3N-1W, Lancaster Quad.). A more accessible, better exposed section that more clearly shows the relations to adjacent groups is now available in a roadcut on the west side of U. S. Highway 151, 5 miles southeast of Platteville (SE SW SE 1, 2N-2W)."

Remarks -- The Platteville Group was defined by Templeton and Willman (1963) as comprising two units, the lower **Pecatonica Formation** and upper **Plattin Subgroup** (fig. 63). In the type Platteville region of Wisconsin-northern Illinois, Platteville strata are primarily dolomite and dolomitic limestones, whereas those rocks in eastern Missouri (Plattin Limestone in northeastern Missouri, Plattin Group in east-central Missouri, and Plattin Group and "Pecatonica Formation" in southeastern Missouri) equivalent to Platteville are purer limestones with much less dolomite. The author of the present report has concluded that although equivalent to the Platteville of northern Illinois, the **Plattin** and **"Pecatonica Formation"** in Missouri are lithologically distinct from typical Platteville; thus, the term "Platteville" is not currently proposed for use in Missouri. The "Pecatonica" and Plattin will be treated as separate units, although it is realized that further work on the sequence called "Pecatonica" may delete the name "Pecatonica," and place the upper part within the Plattin.

Templeton and Willman (1963, p. 65-70) summarized the Platteville Group as follows:

"The Platteville Group is characterized by three regional facies:

"1) A thin, shaly facies in which blue-gray, lithographic, partly dolomitic, thin-bedded limestone with a bryozoan-brachiopod-arthropod fauna predominates." [southeastern Minnesota, northeastern Iowa, southwestern Wisconsin, and the eastern part of the upper peninsula of Michigan]

"2) A thicker, less shaly facies containing similar limestone, but in which partly cherty dolomite with a coralline-molluscan fauna is common or dominant." [northern Illinois, south-central and eastern Wisconsin, and the outlier at Limestone Mountain in the western part of the upper peninsula of Michigan; includes the lower part of the "Pecatonica Formation"]

"3) A thick, relatively pure, slightly shaly facies that consists mainly of dark brown, lithographic, partly

Ser	Stg	Grp	S.G.	Formation	TEMPLETON & WILLMAN (1963) Member	WILLMAN & KOLATA (1978) Member
Champlainian	Trentonian	Galena		Dubuque		
			Kimmswick	Wise Lake	*Stewartville* / *Sinsinawa*	*Stewartville* / *Sinsinawa*
				Dunleith	New London: *Wyota*; Moredock: *Wall*, *Sherwood*, *Rivoli*, *Mortimer*, *Fairplay*; *Eagle Point*; *Beecher*; *St. James*; *Buckhorn*	*Wyota*; Loves Park: *Wall*, *Sherwood*, *Rivoli*, *Mortimer*; *Fairplay*; *Eagle Point*; *Beecher*; *St. James*; *Buckhorn*
			Decorah	Guttenberg	*Glenhaven* / *Garnavillo*	*Glenhaven* / *Garnavillo*
				Kings Lake	*Tyson* / *Mincke*	
				Spechts Ferry	*Glencoe* / *Castlewood*	*Glencoe* / *Castlewood*
	Blackriveran	Platteville	Plattin	Quimbys Mill	*Strawbridge* / *Shullsburg* / *Hazel Green*	*Strawbridge* / *Shullsburg* / *Hazel Green*
				Nachusa	*Everett* / *Elm* / *Eldena*	*Everett* / *Elm* / *Eldena*
				Grand Detour	*Forreston* / *Victory* / *Hely* / *Clement* / *Stillman* / *Wallgreen* / *Dement*	*Forreston* / *Stillman* / *Cowen*
				Mifflin	*Briton* / *Hazelwood* / *Establishment* / *Brickeys* / *Blomeyer*	
				Pecatonica	*Oglesby* / *Medusa* / *New Glarus* / *Dane* / *Chana* / *Hennepin*	*Oglesby* / *Medusa* / *New Glarus* / *Dane* / *Chana* / *Hennepin*

Figure 63. *Comparison of* **Whiterockian** *and* **Mohawkian** *rock units in the Illinois Basin, defined by Willman and Kolata (1978), to those of Templeton and Willman (1963).*

dolomitic, and thin- to thick-bedded limestone. It has a sparse brachiopod fauna." [**southeastern Missouri** to northwestern Indiana; includes the upper "Pecatonica" and Plattin]

"The boundaries betweeen the facies are irregular, gradational, and interfingering, and the facies changes are subordinate to the vertical lithologic changes that define the formations and members...The formations and members can be traced from one facies to another, and they extend from central Tennessee to the upper peninsula of Michigan and eastward to northern New York without important changes in lithology or fauna. Each unit is believed to have been deposited, under remarkably uniform conditions of sedimentation, at practically the same time over a large region."

"Pecatonica Formation"

Hershey, 1894, 1897; Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 73) "In comparison with the underlying Ancell formations, the Pecatonica as a whole is less argillaceous and sandy, has more uniform lithology, contains a different and more abundant fauna, and is more widely distributed. Compared to the overlying Mifflin Formation, the Pecatonica is more dolomitic, much less argillaceous and shaly, less fossiliferous, and thicker bedded...The Pecatonica is further set off from adjacent strata by strong diastems at the base and top."

Type section -- Templeton and Willman (1963, p. 73) stated, "As Hershey designated no type section, a section in the quarries and roadcut on the East Branch of the Pecatonica River, just north of Woodford, Lafayette County, Wisconsin...is proposed." They located this section as (p. 229): "W½ NW NE 14, 2N-5E, South Wayne Quad."

Reference sections -- Exposures that have been identified as "Pecatonica" in Missouri are very limited. The most accessible exposure is in the walls of the Southeast Stone Company quarry, just east of the junction of Missouri Highway 74 and I-55, NW¼ NW¼ NW¼ sec. 24, T. 31 N., R. 13 E., Cape Girardeau County, Cape Girardeau 7½' Quadrangle (fig. 64). Over 400 ft deep, the upper half of the quarry comprises limestone of the lower Plattin Group (Beckett and Bloomsdale Limestones) and the upper part of the "Pecatonica." The lower "Pecatonica" grades into the upper Joachim Dolomite; the exact boundary has not been recorded.

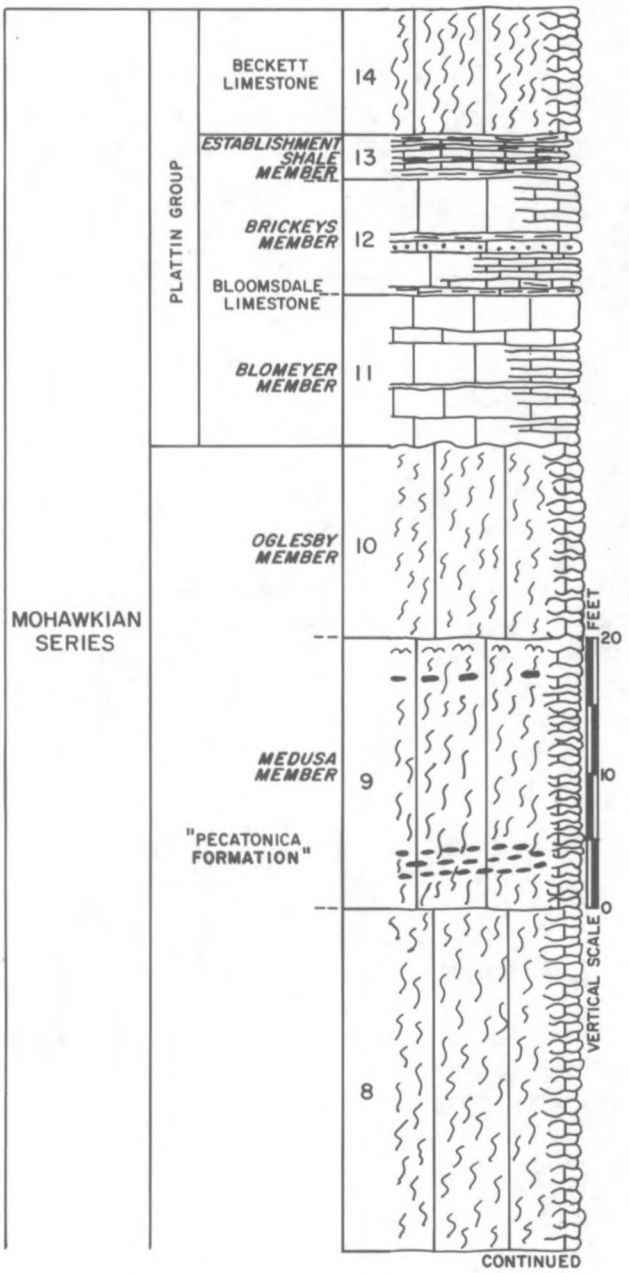
"Pecatonica" strata are also exposed in a small quarry about 1 mi north of Scott City, NE¼ NW¼ NE¼ sec. 31, T. 30 N., R. 14 E., Scott County , Missouri, Scott City 7½' Quadrangle. The original quarry face was not accessible because the quarry floor was flooded, but many large blocks exhibiting the major "Pecatonica" lithologies are scattered about (fig. 65). This quarry was temporarily reactivated in 1987-88, and a new face of part of the upper limestone of the "Pecatonica" (including the distinctive Medusa Member) can presently be seen.

History of nomenclature

1894	**Hershey**	**Pecatonica limestone** (replacement for name "Buff Limestone" in northwestern Illinois)
1935	Kay	Pecatonica Limestone (in Illinois)
1939	Weller and McQueen	Stones River limestone
1948	Grohskopf	Rock Levee formation (upper part; south of Perry County)
1951	Larson	Rock Levee formation (upper part; south of Perry County)
1961	Martin et al. (a)	Rock Levee formation (upper part; south of Perry County)
1963	**Templeton and Willman**	**Pecatonica Formation** (revived and extended to include strata as far south as southeastern Missouri) Oglesby Member Medusa Member New Glarus Member Dane Member Chana Member Hennepin Member (not present in Missouri)
1975	Willman and Buschbach	Pecatonica Formation

1977	Thacker and Satterfield	Pecatonica Formation
1978	Willman and Kolata	Pecatonica Formation (northern Illinois)
1991	**Thompson (present report)**	**"Pecatonica Formation" (southeastern Missouri only)**
		"upper Pecatonica"
		Medusa Member
		"lower Pecatonica"

Remarks -- In southeastern Missouri, there is a sequence of limestone and limestone and dolomite between the Plattin Group and Joachim Dolomite, between the basal members of the Bloomsdale Limestone (Brickeys and/or Blomeyer Members) and the uppermost beds of the Joachim Dolomite. Approximately 140 ft thick in a quarry southwest of Cape Girardeau, these strata were identified as part of the **Rock Levee Formation** by Grohskopf (1948; named from a subsurface section in the region of Rock Levee, now



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
PLATTIN GROUP
Beckett Limestone (35 ft +)
14. Limestone, gray to brown, pure, lithographic to finely crystalline; thick-bedded. (35 ft)
Bloomsdale Limestone (12 ft 10 in.)
Establishment Shale Member (3 ft 10 in.)
13. Shale, blue-green, laminated; interbeds of gray-green to buff argillaceous limestone. (3 ft 10 in.)
Brickeys Member (9 ft)
12. Limestone, gray to purplish-brown, lithographic to finely crystalline; a few thin beds of green shale. (9 ft)
Blomeyer Member (12 ft)
11. Limestone, blue-gray to brown-gray, argillaceous; weathers gray to buff; commonly thin-bedded. (12 ft)
"Pecatonica Formation"
Oglesby Member (14 ft)
10. Limestone, gray, finely crystalline, burrowed, cherty, thick-bedded; burrows filled with brown dolomite. (14 ft.)
Medusa Member (20 ft)
9. Limestone, dense, dark-gray to buff, finely crystalline, finely burrowed thick-bedded to massive; burrows filled with red-brown dolomite; some black chert nodules. (20 ft)
pre-Medusa "upper Pecatonica"
8. Limestone, dark-gray to brown, dense, finely crystalline. (25 ft)

Figure 64. **"Pecatonica Formation"** *and lower part of the Plattin Group exposed in the Southeast Stone Company quarry (Joachim and "Pecatonica"), NW¼ NW¼ NW¼ sec. 24, T. 31 N., R. 13 E., Cape Girardeau County, southeastern Missouri. Adapted from a description by Unfer and Lasater (1981).*

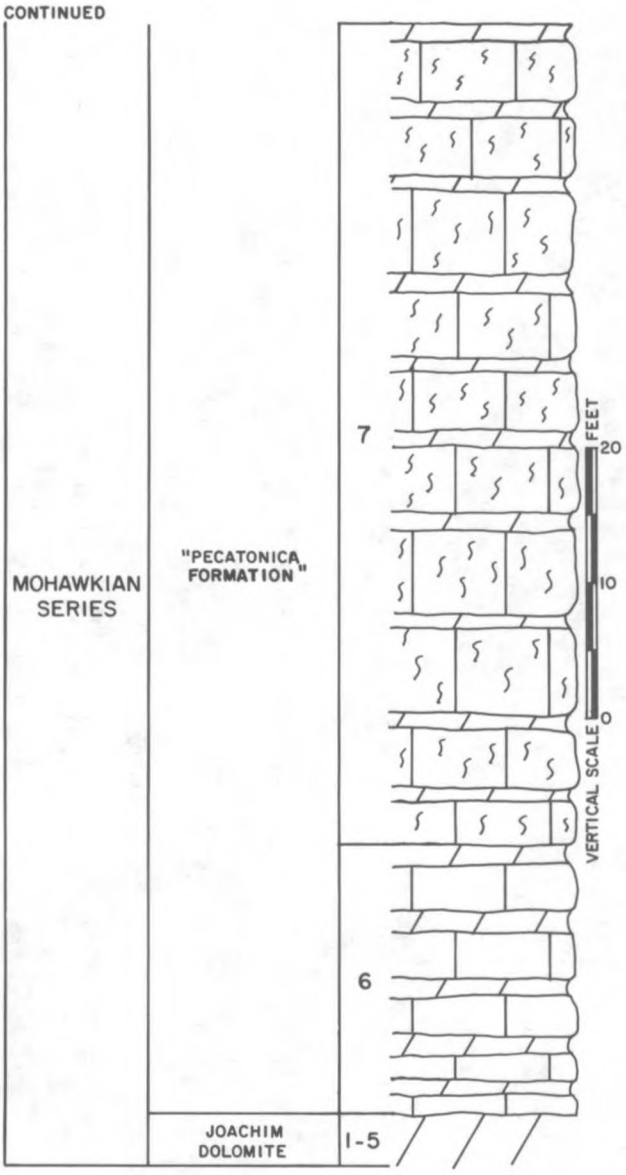


Figure 64 (cont.)

"lower Pecatonica"

7. Limestone, dark-gray to dark-brown, finely crystalline, laminated, thin- to medium-bedded, partly cherty; shale partings; laminated brown dolomite beds. (60 ft)
6. Limestone and dolomite; alternating laminated dark-gray limestone and laminated buff to tan dolomite; thick-bedded; shale partings in lower part. (20 ft)

Joachim Dolomite

5. Dolomite, dark-brown to gray, argillaceous, silty, finely crystalline, thin- to medium-bedded; "algal"; interbedded thin gray laminated limestone. (20 ft)
4. Dolomite, dark-brown to gray, finely crystalline, thick-bedded; some laminated gray limestone. (18 ft)
3. Dolomite, dark-gray to light-gray, silty, finely crystalline; some mottled, thick-bedded; some laminated light-gray limestone. (45 ft)
2. Dolomite, dark-gray to light-gray, finely crystalline, thin- to medium-bedded; shale partings; thin light gray limestone beds. (25 ft)
1. Dolomite, dark-gray to light-gray, pure to silty, finely crystalline, thick-bedded, (45 ft)

the site of the Southeast Stone Company quarry, Cape Girardeau County, southeastern Missouri). These same strata were designated the **"Pecatonica Formation"** by Templeton and Willman (1963). The top of the Rock Levee coincides with that of the "Pecatonica," but the base of the former was marked by a particular chert horizon about 270 ft below the top, now determined to be in the "middle Joachim Dolomite"; hence, north of approximately central Perry County, where the "Pecatonica Formation" pinches out, the "Rock Levee" comprises only the upper part of the Joachim Dolomite, and is wholly a synonym of Joachim.

The "Pecatonica" comprises two parts: an upper massive limestone and a lower sequence of interbedded very dark gray limestone and gray to dark gray dolomite. The upper limestone, much like that of the Beckett Limestone above the Establishment Shale Member of the Bloomsdale Limestone, is a strongly laminated to "algal"-like dark-gray mudstone (fig. 65B). A conspicuous fucoidal zone with dolomite mottling (fig. 65A) in the middle part of the upper limestone was identified as the **Medusa Member** by Templeton and Willman (1963). Other than the Medusa Member, however, the "upper Pecatonica" limestone is difficult to distinguish from limestone of the Plattin Group above the Establishment Shale.

The "lower Pecatonica" contains beds of brown to blue-gray laminated to "birdseye" mottled dolomite (similar to dolomite of the upper Joachim) between dark-gray to nearly black laminated limestone beds. The boundary between "upper" and "lower Pecatonica" is sharp and obvious in the Southeast Stone

Figure 65 (A) ▲ Figure 65 (B) ▼

Figure 65. *The two major limestone facies of the* **" Pecatonica Formation"** *from the Scott City Quarry, NE¼ NW¼ NE¼ sec. 31, T. 30 N., R. 14 E., Scott County, southeastern Missouri, Scott City 7½' Quadrangle.* **(A)** *Burrowed* **Medusa Member**; **(B)** *Unburrowed limestone (above or below the Medusa Member). Photographs by T.L. Thompson.*

Company quarry. The boundary between "Pecatonica" and Joachim is difficult to identify. The Missouri Highway Department identifies "Pecatonica" at the horizon above which the limestone content exceeds that of dolomite; in the underlying "Joachim," the dolomite content exceeds that of limestone.

The top of the "Pecatonica" is marked by the inclusion of beds of dolomite and dolomitic limestone with the oolitic limestone of the overlying Brickeys and Blomeyer Members of the Bloomsdale Formation. Black to pink chert occurs in the upper third of the "Pecatonica."

The sequence called "Pecatonica" is present in the state only in southeastern Missouri (fig. 66). It is reported to be absent north of Perry County, but is as much as 140 ft thick in Cape Girardeau and northern Scott Counties. In Missouri there appear to be few good exposures of "Pecatonica," other than in quarries. Only when the very distinctive Medusa Member is present can "Pecatonica" be definitely identified in outcrop. At least in southeastern Missouri, future work may delete "Pecatonica" as a stratigraphic name, and place the "upper Pecatonica" limestone in the Plattin Group, the "lower Pecatonica" within the Joachim Dolomite. Because of the tentative and questionable future of this name in Missouri, the "Pecatonica" is herein referred to in quotes.

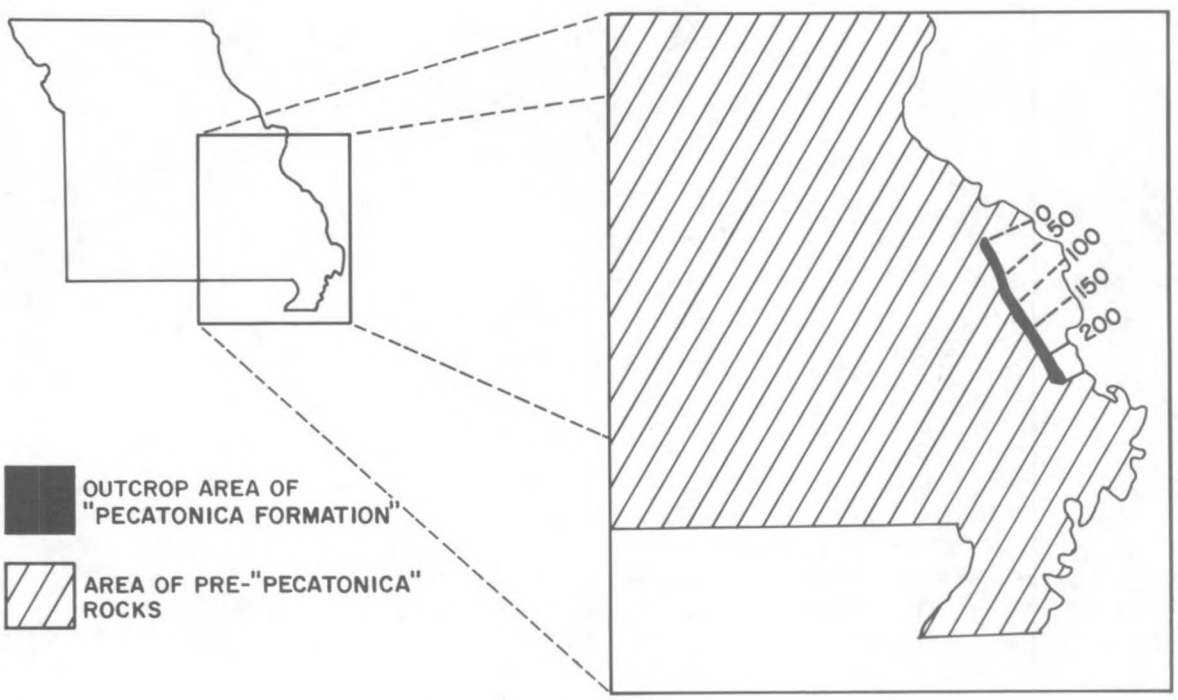


Figure 66. *Isopach map, distribution, and area of outcrop of the* **"Pecatonica Formation"** *in Missouri. Isopach interval is 50 ft.*

Plattin Group

Ulrich, 1904; Larson, 1951

Plattin Limestone

Ulrich, 1904

Original description -- (Ulrich, 1904, p. 111) "The Plattin limestone is a new name proposed for the fine grained limestone formation between the Kimmswick and the 'First Magnesian' [Joachim Dolomite] and which has generally been called either Trenton or lower Stones River group in central Kentucky and Tennessee. The formation takes its name from Plattin Creek, Jefferson county [Missouri], near the mouth of which it is well exposed."

Type section -- The Plattin was named from exposures near the mouth of Plattin Creek, Jefferson County, Missouri, near the corner of secs. 4, 5, 8, and 9, T. 40 N., R. 6 E., Selma 7½' Quadrangle (fig. 67). No specific section has been designated as the type.

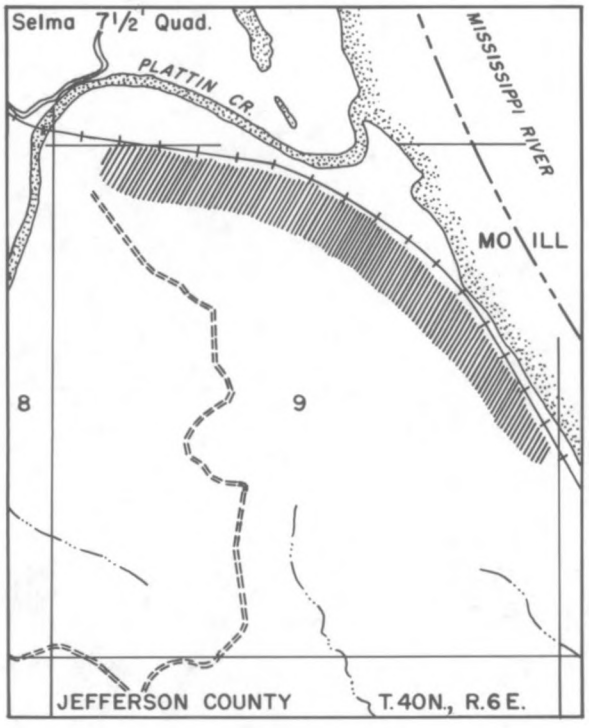
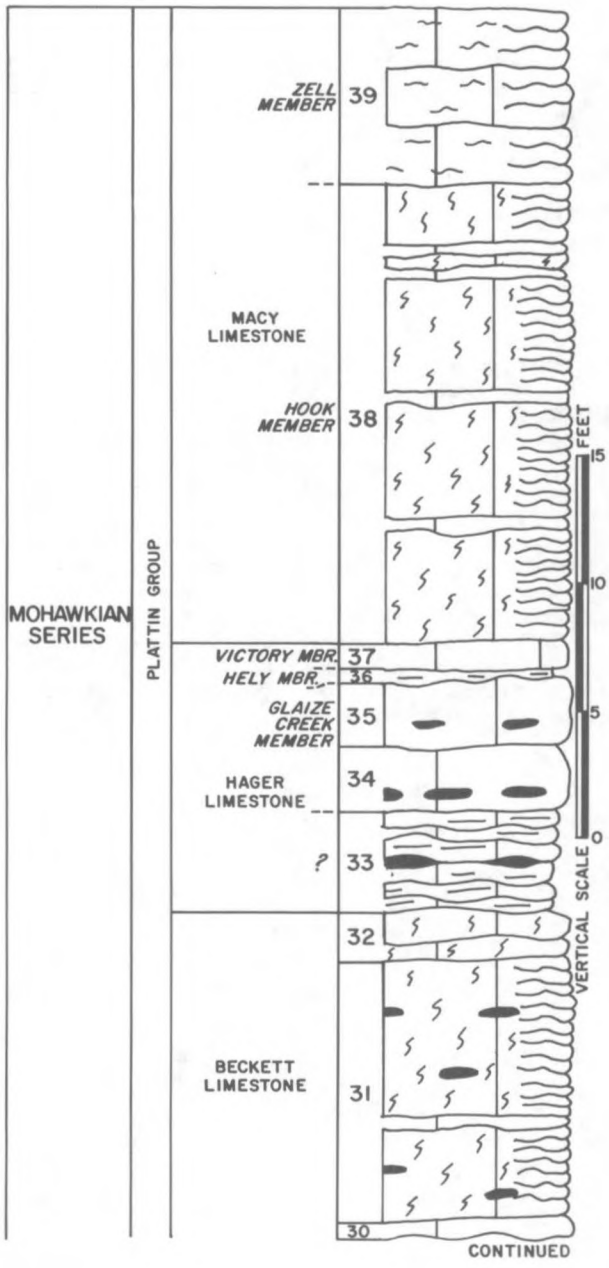


Figure 67. *Part of the Selma 7½' Quadrangle, showing location of the type area of the* **Plattin Group.**

Reference sections -- An excellent exposure from "middle Joachim Dolomite" to the Macy Limestone of the Plattin Group is in a series of roadcuts on Missouri Highway 30 near Weber Hill, NE¼ sec. 27, T. 43 N., R. 4 E., Jefferson County, House Springs 7½' Quadrangle (fig. 68). Another succession of between 80 and 90 ft of Plattin Group is in a composite of roadcuts on I-55, beginning 0.5 mi north of the bridge over Joachim Creek (mile post 180), eastern Jefferson County, east-central Missouri, W½ NW¼ sec. 19, T. 41 N., R. 6 E., Herculaneum 7½' Quadrangle. The Brickeys and Establishment Shale Members of the Bloomsdale Limestone; the Beckett Limestone; the Glaize Creek, Hely, and Victory Members of the Hager Limestone; and the Hook and Zell Members of the Macy Limestone are present in these exposures (figs. 69 and 70A).

The lower part of the Plattin Group is well exposed in a roadcut on a side road to Missouri Highway 30, 1.5 mi north of Cedar Hill, center S½ NW¼ sec. 18, T. 42 N., R. 4 E., Jefferson County, Missouri, House



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

PLATTIN GROUP

Macy Limestone (27 ft)

Zell Member (7 ft)

39. Limestone, light-gray, sublithographic, burrowed; thick (1 in.) horizontal burrowing, 50% of unit is brown burrow-fill material. (6-8 ft)

Hook Member (20 ft)

38. Limestone, light-gray to light-gray-brown, sublithographic, burrowed; calcite-filled vugs 4 ft above base; scour surface at fine-grained calcarenite 4.5 ft above base; prominent calcarenite 8.5 ft above base; 13.5 ft to bed with circular burrows between two calcarenite beds. (16 ft 6 in.)

Hager Limestone (6-10 ft)

Victory Member (1 ft)

37. Limestone, very light-gray, lithographic, laminated; bluish "birdseye" structures; top transitional with no. 38. (1 ft)

Hely Member (1-3 in.)

36. Limestone, dark-gray, argillaceous, slabby, nodular beds. (1-3 in.)

Glaize Creek Member (8 ft 2 in.)

35. Limestone, very light-gray, lithographic, 1/8 in. vertical burrows; scattered brown to gray 1- to 2-in. chert nodules 1 ft above base; top at shaly bed (Hely Member). (2 ft 6 in.)
34. Limestone, very light gray, sublithographic to finely calcarenitic; discontinuous band of 2- to 4-in. light gray chert nodules 1 ft above base; upper 6 in. argillaceous in places. (2 ft 4 in.)
33. Limestone, gray, argillaceous to very finely calcarenitic; in irregular wavy bads; basal bed 1 ft thick, upper beds 1- to 2-in. thick; subspherical chert nodules in middle; top irregular. (3 ft 6 in.)

Beckett Limestone (90 ft)

32. Limestone, light gray, coarsely burrowed; two beds. (2 ft)
31. Limestone, like no. 29, very irregular discontinuous calcarenite beds; weathers slabby, very thick calcarenite bed 4.5 ft above base. At junction of Gravois Road and Highway 30. (12 ft)
30. Limestone, fine- to medium-crystalline calcarenite; irregular base, even top; rip-up conglomerate in lower 1-2 in. (4-6 in.)

Figure 68. *"Upper Joachim Dolomite" and* **Plattin Group** *exposed in roadcuts on Missouri Highway 30 near Weber Hill, NE¼ sec. 27, T. 43 N., R. 4 E., Jefferson County, Missouri, House Springs 7½' Quadrangle. Described by T.L. Thompson, 1987.*

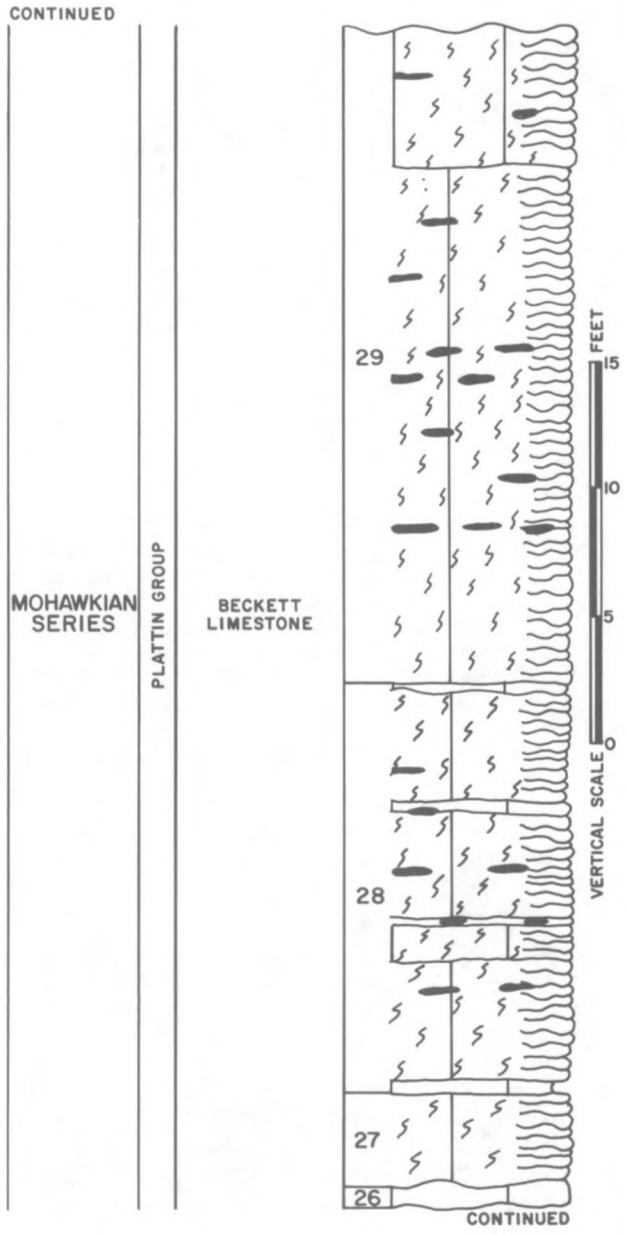


Figure 68 (cont.)

29. Limestone, like no. 28; highly burrowed lower 6 ft; scattered light-gray chert nodules and calcarenite beds; discontinuous chert bed 6 ft above base; some chert nodules dark gray to black when fresh; chert zone (10%) 11-13 ft above base; continuous chert beds 20 ft above base; prominent calcarenite bed at top. (25 ft)
28. Limestone, light-gray, mudstone to sublithographic, burrowed; fewer calcarenite beds than in no. 27; base at 1-in. shale bed; zone of small white to dark-gray shattered and brecciated chert nodules 3 ft 9 in. above base; continuous chert zone 7 ft above base, chert gray, weathering yellow-brown; continuous calcarenite beds prominent above 7 ft from base; continuous bedding plane 11 ft from base; good 2-in. calcarenite at top, a scour surface. (16 ft)
27. Limestone, light-gray, sublithographic, highly burrowed with dark-gray filling; fossiliferous; several 1- to 2-in. finely crystalline calcarenite bed sand lenses with conglomerate zones in lower part; circular "burrows"; top at prominent 1-in. shaly zone; no chert. (3 ft 8 in.)
26. Limestone, dark gray, finely crystalline calcarenite; irregular top and base; fossiliferous; large calcite crystals; contact with no. 27 transitional or "welded," and conglomeratic; forms prominent dark bed in exposure. (8 in.)

Units 26-29 measured on southeast side of Highway 30 and at junction of Highway 30 and Gravois Road. Units 1-25 measured on northwest roadcut of Highway 30, sections matched by unit no. 26, the thin dark-gray calcarenite.

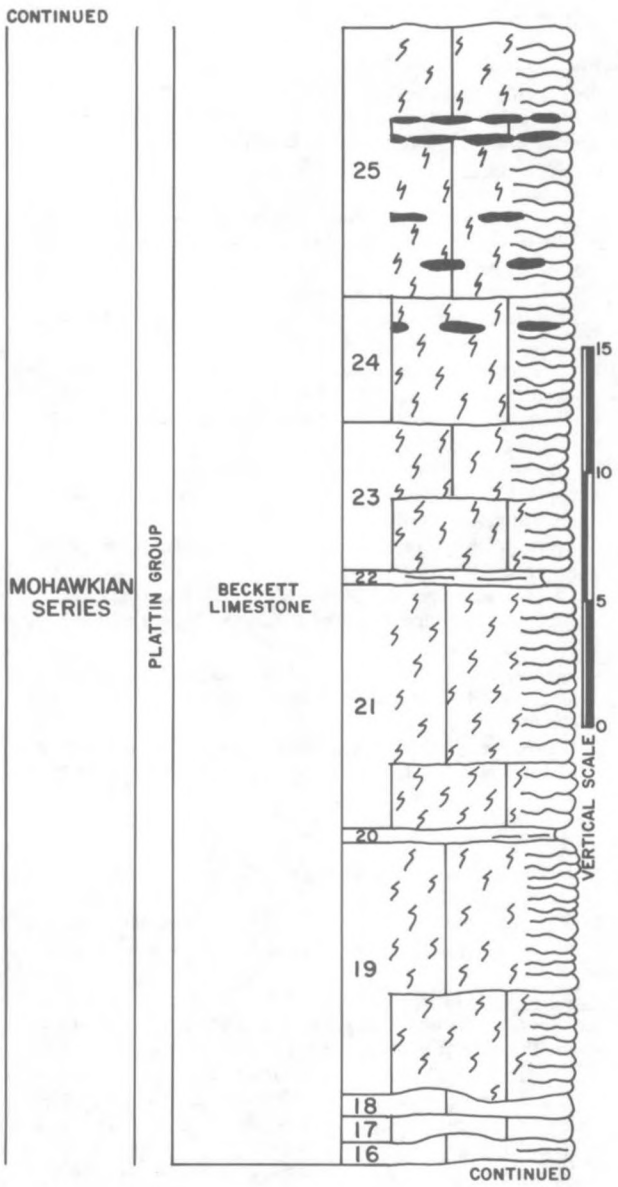


Figure 68 (cont.)

25. Limestone, light-gray, sublithographic, burrowed, nodular; lighter than no. 24; gray burrow-filling; fossiliferous (*Tetradium*); two continuous chert beds 5.5 ft above base; top, very irregular, at base of dark-gray calcarenite bed (no. 26) 6-in above lowest chert in exposure. (10 ft)
24. Limestone, like no. 23; scattered 2- to 4-in. yellow-brown chert nodules 4 ft above base, at base of breccia bed in 1- to 2-in. fine-grained calcarenite. (4 ft 6 in.)
23. Limestone, light-gray, lithographic, burrowed; two 3-ft beds; ¼- to ½-in. burrows with brown filling; weathers pitted. (6 ft)
22. Limestone, like no. 20; prominent reentrant; darker gray, and shaly. (4-6 in.)
21. Limestone, like no. 19; two beds, lower 3-ft and upper 6-ft. (9 ft)
20. Limestone, gray, fossiliferous, very shaly; thin 1/8- to ¼-in. nodular beds. (1-2 in.)
19. Limestone, light-gray, lithographic, burrowed, very nodular; top at prominent 1/2- to 1-in. shale bed; thin calcarenitic lenses; prominent flat scour surface 3 ft below top. (10 ft)
18. Limestone, gray, argillaceous, burrowed, fossiliferous (tubular bryozoans ?); irregular top; basal 1- to 2-in. more lithographic. (8-10 in.)
17. Limestone, gray, medium crystalline calcarenite, fossiliferous; wavy base, abrupt top (scour surface). (8-10 in.)
16. Limestone, gray, very nodular, argillaceous; may be brecciated or conglomeratic; very fossiliferous; wavy top. (8-10 in.)

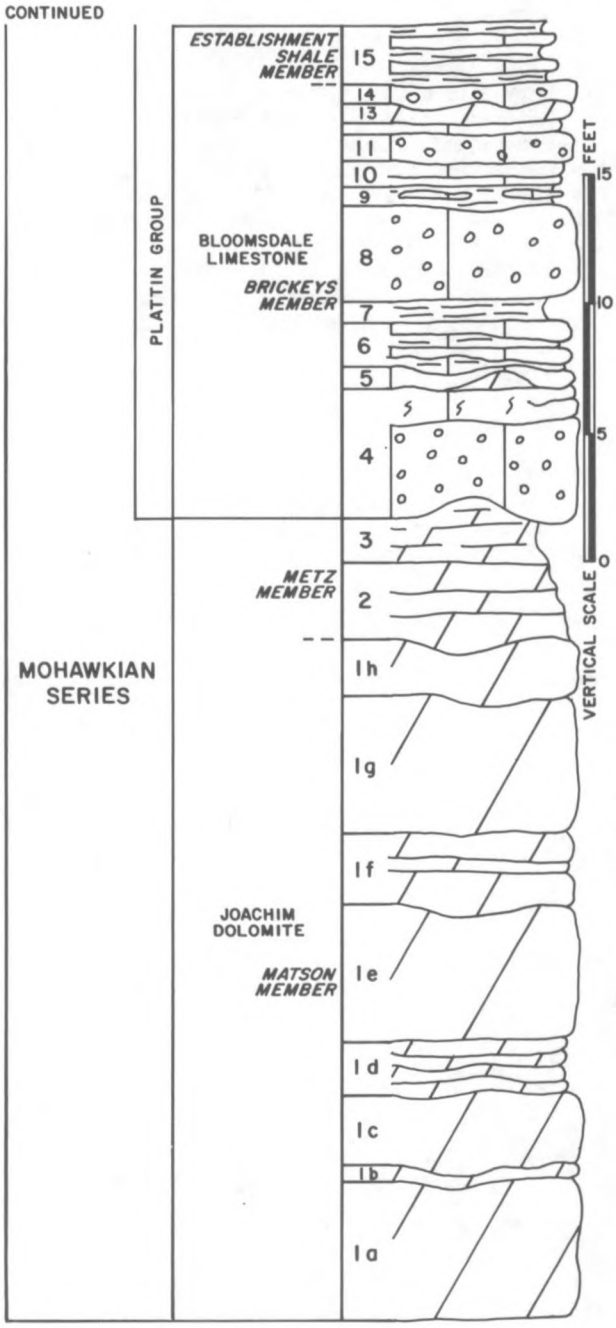


Figure 68 (cont)

Bloomsdale Limestone (17 ft)

Establishment Shale Member (2 ft)

15. Shale, bluish-gray, platy to fissile; interbedded with 1- to 4-in. beds of brown sublithographic limestone. (2 ft)

Brickeys Member (15 ft)

14. Limestone, chocolate-brown to brown, sublithographic to finely calcarenitic, oolitic; upper 4 in. lighter brown. (8-10 in.)
13. Dolomite, yellow-brown, finely crystalline; irregular top. (6-8 in.)
12. Limestone, like no. 10; one bed. (4-6 in.)
11. Limestone, chocolate-brown, sublithographic, oolitic, laminated; lower 3 in. calcarenitic. (1 ft)
10. Limestone, very light bluish-gray sublithographic or mudstone, "birdseye" structures; two beds. (10 in.)
9. Shale, grayish-green; interbedded with brown lenticular calcarenitic limestone. (4-6 in.)
8. Limestone, like no. 4; oolitic; basal 1 ft burrowed (¼ in.), upper 1 ft calcarenitic; ½- to 1-in. thick lenses of light gray mudstone with "birdseye" structures. (3 ft 10 in.)
7. Shale, greenish-gray, blocky to platy, irregular; forms prominent reentrant. (6-8 in.)
6. Limestone, greenish-gray, very argillaceous, slabby; lenses of more pure brown calcarenite at top and in upper one-third. (1 ft 6 in.)
5. Limestone, brown, lithographic, irregular; with lenticular discontinuous 1- to 4-in. nodular dolomite bed between nos. 4 and 5. (4-8 in.)
4. Limestone, chocolate brown, lithographic to calcarenitic, oolitic; lower 3 ft lithographic, upper 1.5 ft nodular or burrowed; very irregular base. (4 ft 6 in.)

Joachim Dolomite

Metz Member (5-6 ft)

3. Dolomite, bluish-gray to brown, blocky to shaly; top very irregular. (2-3 ft)
2. Dolomite, bluish-gray to yellow-brown, mudstone, blocky; red-brown "birdseye" structures; base irregular, grades upward into no. 3. (3 ft)

Matson Member (25 ft)

1. Dolomite, tan; alternating thick medium crystalline algal beds and thin sublithographic to mudstone beds; from top down:
   h. massive algal, medium crystalline (2 ft);
   g. massive algal, medium crystalline, calcite crystals (4 ft);
   f. thin-bedded laminated mudstone, "birdseye" structures (3 ft);
   e. massive algal, irregular top, large calcite crystals (5 ft);
   d. sublithographic, or mudstone, in four 6-in. beds (2 ft);
   c. massive algal (3 ft);
   b. sublithographic to mudstone (6 in.);
   a. massive algal. (5 ft)

Base of section at Byrnes Road intersection.

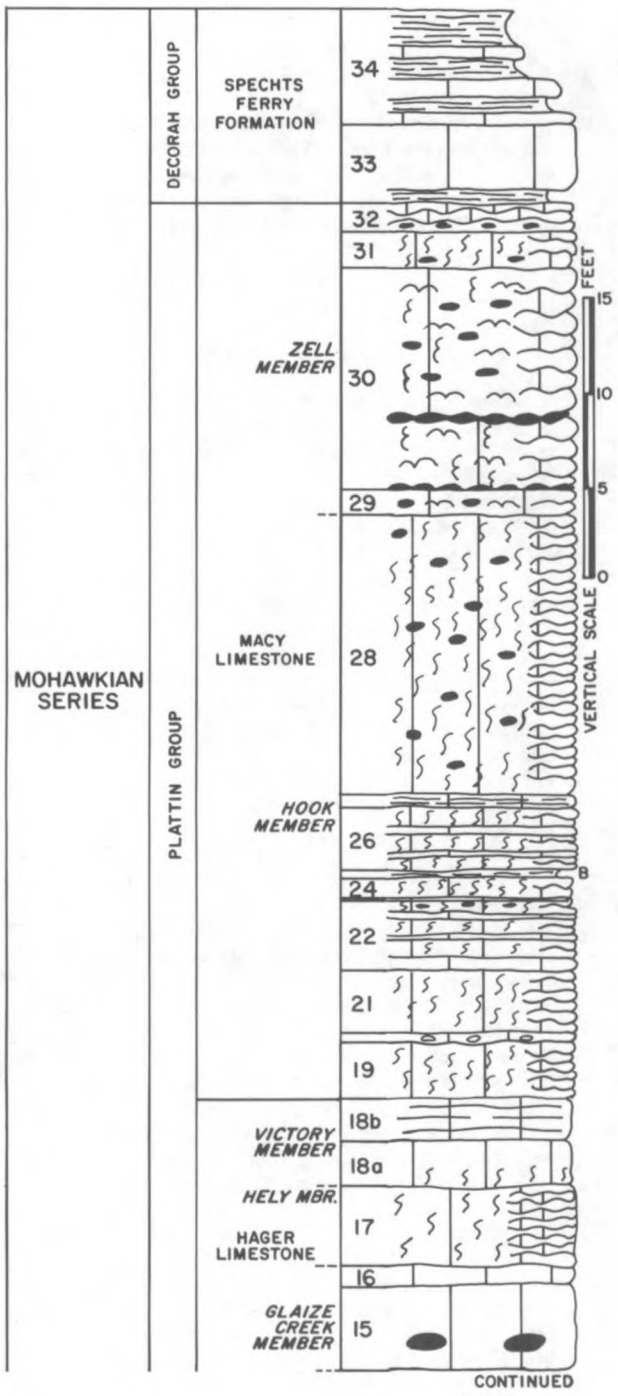


Figure 69. *Exposures of the* **Plattin Group** *in roadcuts on I-55, from 0.5 mi north of the bridge over Joachim Creek (mile post 180), W½ NW¼ sec. 19, T. 41 N., R. 6 E. to NE¼ SE¼ sec.12, T. 41 N., R. 5 E., Jefferson County, southeastern Missouri, Herculaneum 7½' Quadrangle. Includes the Bloomsdale (Brickeys and Establishment Shale Members), Beckett, Hager (Glaize Creek, Hely, and Victory Members), and Macy (Hook and Zell Members) Limestones. Described by T.L. Thompson, 1986.*

ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
DECORAH GROUP
Spechts Ferry Formation
Glencoe Shale Member (6 ft)
34. Shale, green, clayey; with thin even beds of purplish-brown, very fossiliferous limestone. (6 ft)
Castlewood Limestone Member (3 ft 6 in.)
33. Limestone, gray, finely crystalline, fossiliferous; 6-in. bentonite (Diecke K-bentonite Bed) and green shale at base. (3 ft 6 in.)
PLATTIN GROUP
Macy Limestone (43 ft)
Zell Member (15 ft)
32. Limestone, gray, lithographic, burrowed; wavy, nodular beds; white to buff chert in lower part. (1 ft 8 in.)
31. Limestone, gray to buff, sublithographic; 0.25-0.5-in. burrows in gray lower half; buff upper half; discontinuous brown chert bed at base. (1 ft 8 in.)
30. Limestone, gray, lithographic; 1-2-in. horizontal, brown dolomite-filled burrows, 50% dolomite; 0.5-in. brown chert bed at base and scattered nodules throughout; continuous chert bed 3 ft 4 in. above base, 1 ft above thin shale parting. (10 ft 6 in.)
29. Limestone, lithographic; interbedded fine-grained calcarenite; horizontal 1-2-in. burrows; irregular beds; scattered brown chert nodules. (1 ft 2 in.)
Hook Member (28 ft 4 in.)
28. Limestone, gray, finely crystalline to sublithographic; 0.25-0.5-in. burrows; chert nodules scattered throughout; top at prominent bedding plane. (15 ft)
27. Limestone, gray, laminated, calcarenitic, unburrowed. (6 in.)
26. Limestone, dark-gray, sublithographic, mostly burrowed; several 1-2-in. unburrowed calcarenite beds; discontinuous beds of nodular brown chert. (2 ft 8 in.)
25. Shale, brown. (1 in.)
24. Limestone, very irregular, nodular, wavy, heavily burrowed, fossiliferous; bluish chert nodules; top at shale. (10 in.)
23. Limestone, lithographic, burrowed. (1 in.)
22. Limestone; alternating unburrowed calcarenite and burrowed lithographic; from base up: 6-in. medium crystalline, silty, unburrowed; 6-in. burrowed; 6-in unburrowed; 8-in. burrowed; 2-in burrowed; 1 ft 6 in. burrowed and cherty. (3 ft 2 in.)
21. Limestone, like no. 19. (3 ft)
20. Limestone, buff, fine-grained calcarenite; single, irregular bed; pebble conglomerate in lower part. (3-7 in.)
19. Limestone, gray to gray-brown, sublithographic; 0.25-0.5-in. burrows. (2 ft 8 in.)
Hager Limestone (14 ft 3 in.)
Victory Member (5 ft)
18b. Limestone, light-gray, laminated, algal; weathers off-white; contains pebble conglomerate. (2 ft 6 in.)
18a. Limestone, light-gray to buff, lithographic; lower half with 0.25-0.5-in. burrows, upper half unburrowed; single bed. (2 ft 6 in.)
Hely Member (4 ft 6 in.)
17. Limestone, light blue-gray, sublithographic, 0.25-in. burrows; in thin wavy beds. (4 ft 6 in.)
Glaize Creek Member (4 ft 9 in.)
16. Limestone, light-gray, lithographic; single bed; vertical burrows in upper 1-2-in. (0 ft 6 in.)
15. Limestone, light-gray, lithographic to very finely calcarenitic, essentially one bed; band of large brown discrete round chert nodules about 1-ft above base. (4 ft 3 in.)

The units above (nos. 15-34) were measured on the east side of I-55, north of the interchange with Jefferson County road Z, in sec. 19. The units below (nos. 1-18) were measured on the west side of I-55, south of the interchange with County road Z, at mile post 180, in sec. 12.

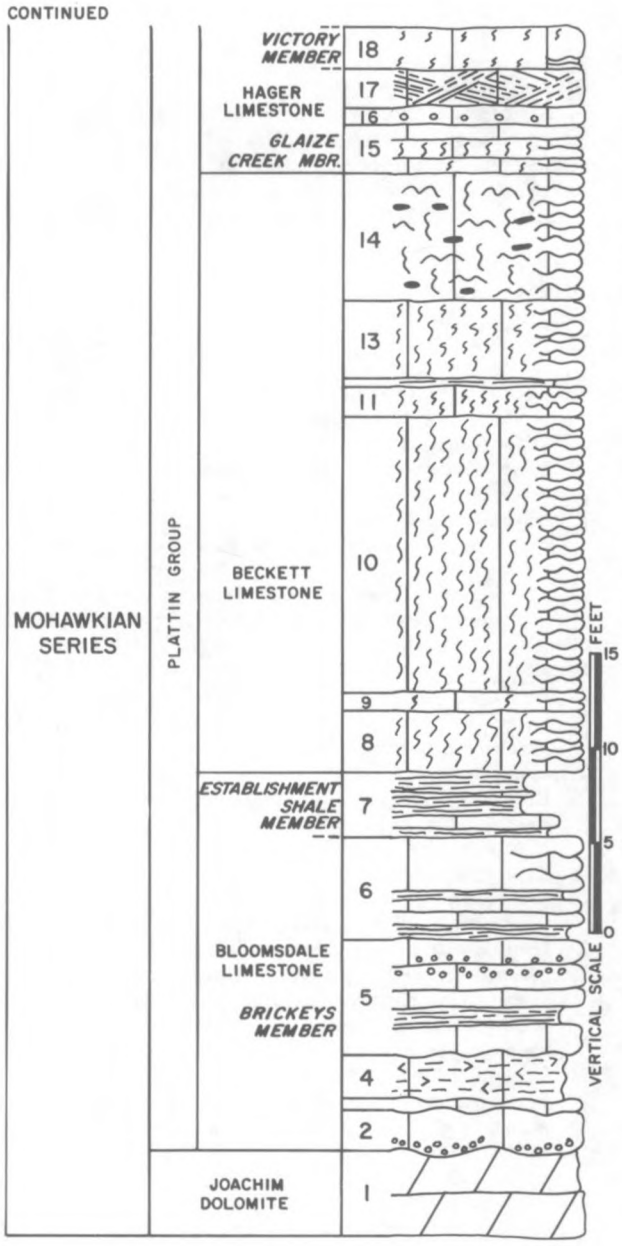


Figure 69 (cont.)

Hager Limestone (8 ft 5 in.)

Victory Member (3 ft 7 in.)

18. Limestone, light-gray, weathers white, lithographic; lower 6 in. hackly, burrowed; upper 1 ft unburrowed, laminated; top 3 in. with 0.15-in. vertical burrows; forms prominent white bed in outcrop; 15-20 ft exposed above, but top of Plattin exposed in outcrop described above (units 15-34). (1 ft 5 in.)

Glaize Creek Member (4 ft 10 in.)

17. Limestone, dark-gray, finely crystalline, calcarenitic, cross-laminated, not visibly burrowed; single bed (**Clement grainstone facies**). (1 ft 8 in.)
16. Limestone, like no. 17, light-gray; welded to top of no. 15. (6 in.)
15. Limestone, gray, alternating lithographic and fine-grained calcarenite; 0.25-0.5-in. burrows in lithographic beds; upper half predominantly calcarenite, with stringers of burrowed lithographic and medium-grained calcarenite; discontinuous chert beds 1-2 in. thick; lower 6 in. brecciated remnants of no. 14. (2 ft 6 in.)

Beckett Limestone (27 ft 6 in.)

14. Limestone, gray, lithographic, incipient wavy bedding, large (1-2 in.) filled horizontal and vertical burrows; yellow-brown chert in round and irregular 1-2 in. nodules. (6 ft)
13. Limestone, dark-gray, sublithographic; sparse 0.25-0.5 in. burrows; incipient wavy beds on thick beds. (3 ft 10 in.)
12. Shale, brown, clayey; prominent reentrant. (4 in.)
11. Limestone, gray, very hackly; almost a breccia. (1 ft 3 in.)
10. Limestone, like no. 8; no chert. (12 ft 6 in.)
9. Limestone, dark-gray, sublithographic, sparsely burrowed; incipient wavy beds in upper half; lower 4-in bed and three 2-in. beds. (10 in.)
8. Limestone, light-gray to dark-gray, sublithographic; very hackly, incipient beds; small 0.25-0.5-in. burrows. (3 ft 2 in.)

Bloomsdale Limestone (17 ft 6 in.)

Establishment Shale Member (3 ft)

7. Shale and limestone. Shale, green, clayey, fissile, 80% of unit; limestone, gray, sublithographic; as thin beds between shale beds. Base at 6-in. limestone above basal 1-in. shale. (3 ft)

Brickeys Member (14 ft 6 in.)

6. Limestone, chocolate-brown, in slightly nodular beds; lower 2 ft argillaceous, upper part very dense, sublithographic; interbedded with 0.5-1 in. shale. (5 ft)
5. Limestone, chocolate-brown, sublithographic; even 4-6-in. beds; uneven base; 6-in. shale zone 2 ft above base. (4 ft 5 in.)
4. Limestone, dull-gray, dolomitic, shaly; weathers blocky to fissile; wavy top and base. (2 ft)
3. Limestone, dark-gray, finely crystalline to sublithographic, very irregular, nodular. (0-6 in.)
2. Limestone, chocolate-brown, finely crystalline to sublithographic; weathers gray; lower part finely oolitic and medium calcarenite; base very irregular. (2 ft - 2 ft 6 in.)

Joachim Dolomite

Matson and Metz Members (20 ft +)

1. Dolomite and shaly dolomite. (20 ft)

Base at highway level

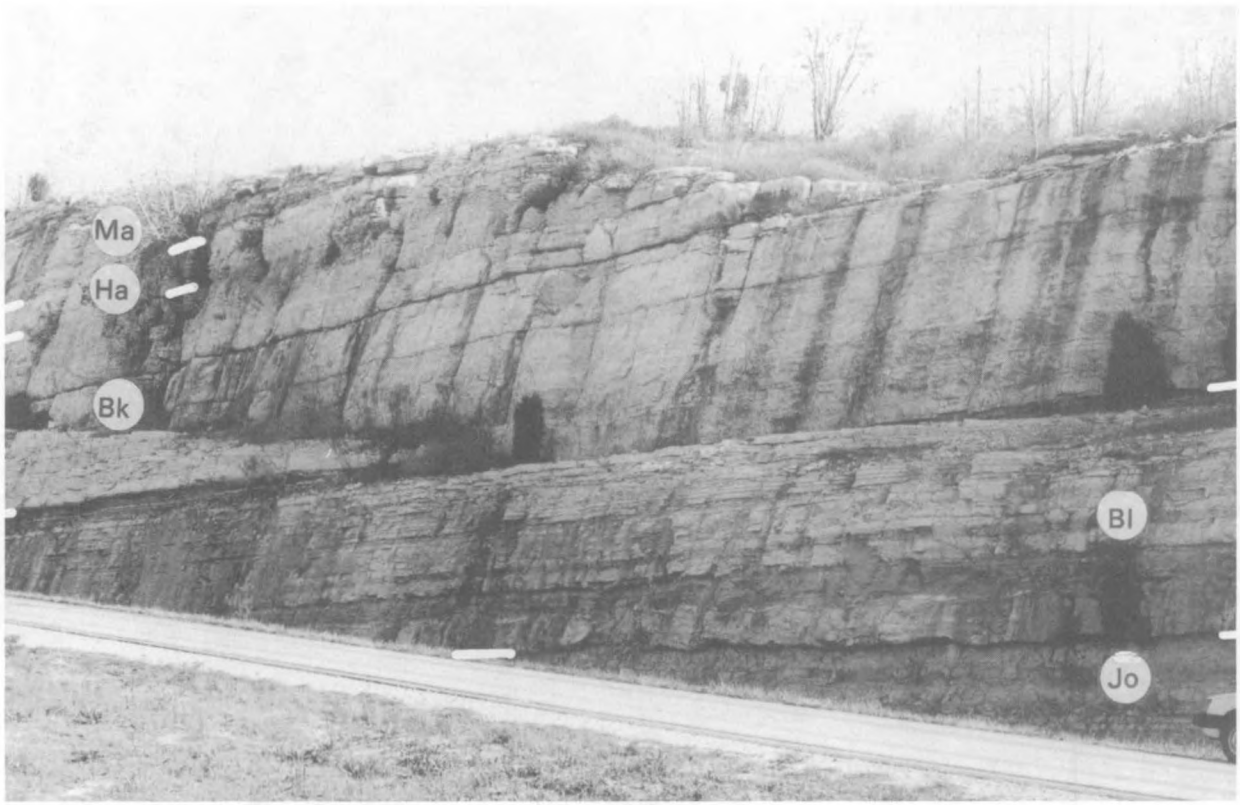


Figure 70 (A)

Figure 70. *Lower part of the* **Plattin Group**. **(A)** *Roadcut on I-55, beginning 0.5 mi north of bridge over Joachim Creek (mile post 180), W½ NW¼ sec. 19, T. 41 N., R. 6 E., Jefferson County, Missouri (fig. 69).* **(B)** *Roadcut on a side road to Missouri Highway 30, center S½ NW¼ sec 18, T. 42 N., R. 4 E., Jefferson County, Missouri (fig. 71).* **(Jo)** *Joachim Dolomite;* **(Bl)** *Bloomsdale Limestone;* **(Bk)** *Beckett Limestone;* **(Ha)** *Hager Limestone;* **(Ma)** *Macy Limestone. Photographs by T.L. Thompson.*

Springs 7½' Quadrangle (figs. 70B and 71). At this section, the Brickeys and Establishment Shale Members of the Bloomsdale Limestone and the Beckett Limestone are exposed.

Another excellent reference section to the Plattin Group is a composite of two roadcuts on I-44, just west of the interchange at the Six Flags amusement park (Allenton exit), SW¼ SE¼ and center south line SW¼ sec. 33, T. 44 N., R. 3 E., St. Louis County, Eureka 7½' Quadrangle (fig. 72). A succession from the top of the Establishment Shale Member to the Kimmswick Limestone is exposed. The Plattin Group includes the Beckett Limestone, Victory Member of the Hager Limestone, and the Hook and Zell Members of the Macy Limestone. To supplement this section, a roadcut on Loop 44 (old U.S. Highway 66) just east of Pacific, 0.5 mi south of I-44, center S½ N½ sec. 4, T. 43 N., R. 3 E., Pacific 7½' Quadrangle, includes the Brickeys and Establishment Shale Members of the Bloomsdale Limestone, and the Beckett Limestone (fig. 73).

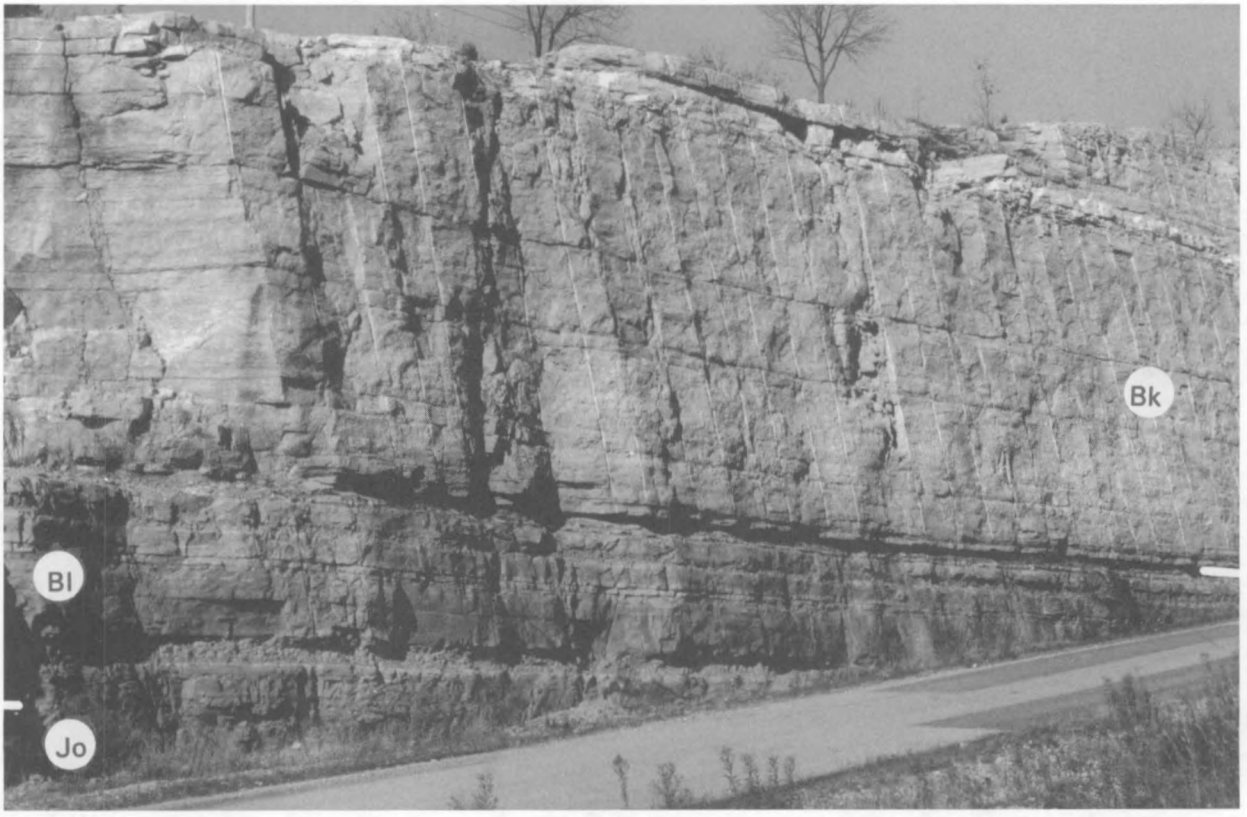
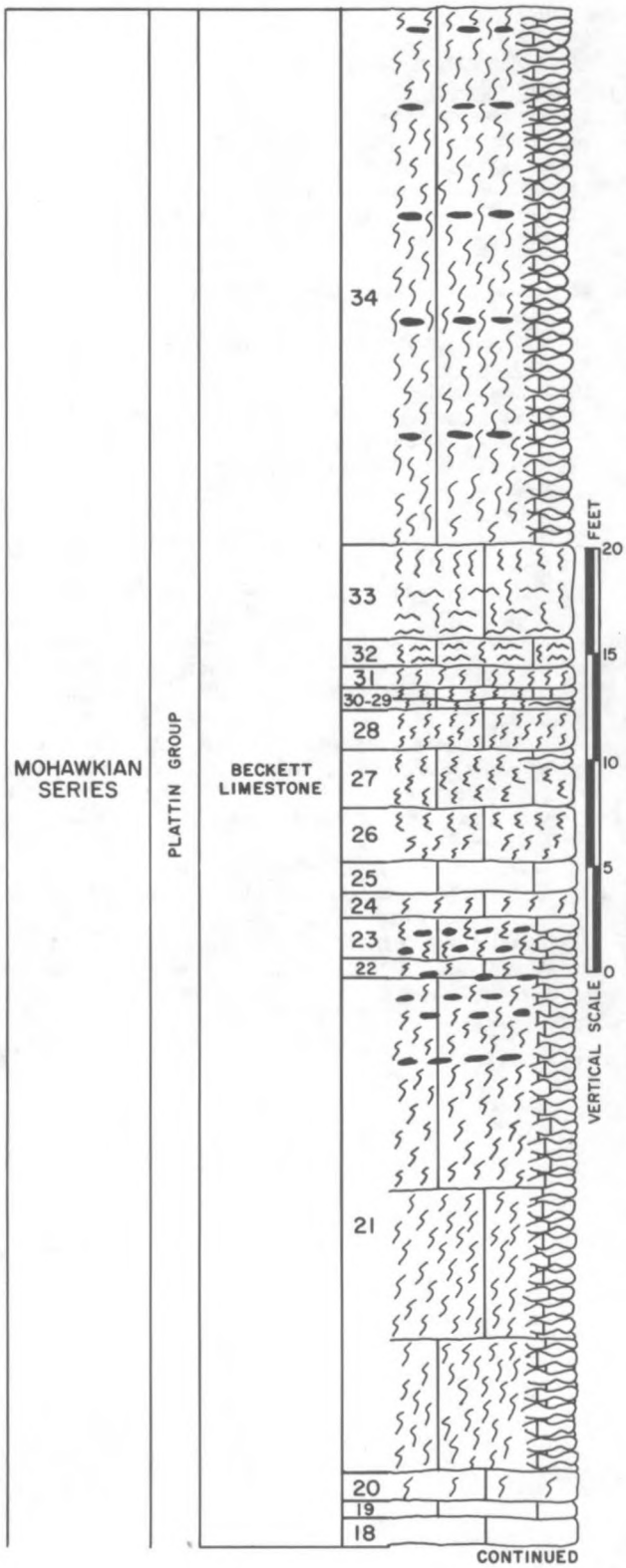


Figure 70 (B)

A roadcut on St. Charles County road F, 1.5 mi northwest of Defiance, just east of a bridge over the Femme Osage River, exposes at least the lower two-thirds of the Plattin Group. Located in the SW¼ NE¼ SE¼ sec. 21, T. 45 N., R. 2 E., Defiance 7½' Quadrangle, this section includes the Brickeys Member of the Bloomsdale Limestone; the Beckett Limestone; Glaize Creek, Hely, and Victory Members of the Hager Limestone; and the lower part of the Macy Limestone (fig. 74).

A section of the much thinner Plattin Limestone sequence of northeastern Missouri is in a roadcut on U.S. Highway 61, Ralls County, SE¼ SE¼ sec. 21, T. 55 N., R. 4 W., Hannibal SE 7½' Quadrangle (fig. 75). The Plattin Limestone, including the poorly exposed Establishment Shale Member, but not the Victory Member, is here overlain by Decorah and Kimmswick carbonates; it is only about 45 ft thick and overlies 30 ft of poorly exposed Joachim Dolomite.



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
PLATTIN GROUP
Beckett Limestone (70 ft)

34. Limestone, light-gray, lithographic, heavily burrowed (0.25-0.5 in.); 4 to 5 nodular chert beds from 30 in. above base to top of unit. (25 ft).
33. Limestone and dolomite; prominent horizontal burrowing lower half; 50% dolomite; very fossiliferous, scattered thin medium-grained calcarenite beds; grades upward to heavily burrowed limestone; coarser calcarenite beds toward top; top at prominent bedding plane. (4 ft 7 in.)
32. Limestone, light-gray; prominent dolomite-filled, horizontal burrows. (1 ft 3 in.)
31. Limestone, light-gray, very finely burrowed (0.15-0.25 in.). (8 in.)
30. Limestone, gray, heavily burrowed (0.5-1 in.); thin bed of medium-grained calcarenite at base. (4 in.)
29. Limestone, light-gray, lithographic; very hackly, incipient bedding; few burrowed zones. (4 in.)
28. Limestone, light-gray, lithographic, heavily burrowed (0.5 in.). (1 ft8 in.)
27. Limestone, light-gray, lithographic, coarsely burrowed (0.5-1 in.); top 6-in. hackly. (2 ft 10 in.)
26. Limestone, light-gray, lithographic to sublithographic, finely burrowed (0.25-0.5 in.); top 6-in. coarsely (1-2 in.) burrowed. (2 ft 4 in.)
25. Limestone, very light-gray, lithographic, unburrowed; conchoidal fractures. (1 ft 8 in.)
24. Limestone, light-gray to white, lithographic; widely spaced 0.25-in. burrows. (9 in.)
23. Limestone, like no. 22; 0.5-1-in. burrows that are fewer and farther apart than in no. 22; chert at base and two-thirds toward top; thickness varies; base irregular. (2 ft).
22. Limestone, gray, lithographic; denser and with fewer burrows than no. 21; base at zone of round chert nodules ; contact with no. 21 transitional. (1 ft)
21. Limestone, light-gray, lithographic; evenly spaced, yellow-brown, dolomite-filled, 0.25-0.5 in. burrows; middle 6 in. has some dark-gray burrow-filling; base irregular on no. 20; first prominent bedding plane 6 ft 4 in. above base; nodular beds of chert in upper third. (23 ft 6 in.)
20. Limestone, dark-gray, lithographic, dense; weakly burrowed in middle; calcite-filled vugs. (1 ft 3 in.)
19. Limestone, light-gray, lithographic to sublithographic, sparsely burrowed; lighter gray than no. 20; transitional to no. 18. (7 in.)
18. Limestone, very fossiliferous (bryozoans) medium-grained calcarenite; upper 3 ft more finely crystalline. (1 ft 6 in.)

Figure 71. **Plattin Group** *exposed 1.5 mi north of Cedar Hill, at the junction of a side road with Missouri Highway 30, center S½ NW¼ sec 18, T. 42 N., R. 4 E., Jefferson County, Missouri, House Springs 7½' Quadrangle. Well exposed are the Bloomsdale (Brickeys and Establishment Shale Members) and Beckett Limestones. Described by T.L. Thompson, 1986.*

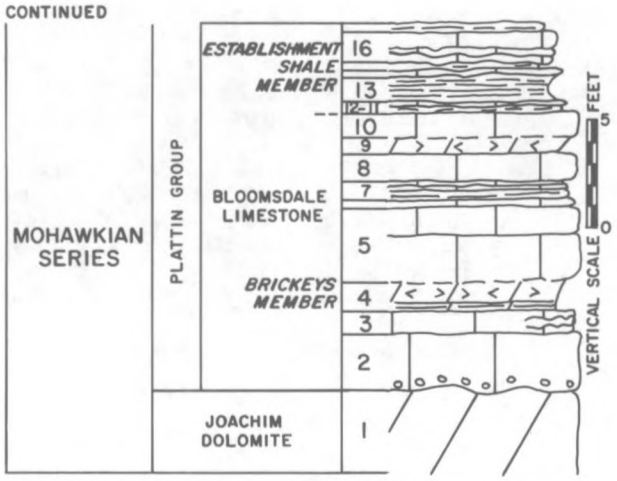


Figure 71 (cont.)

Bloomsdale Limestone (15 ft 4 in.)
Establishment Shale Member (3 ft 5 in.)

17. Shale parting, calcareous. (0.5 in.)
16. Limestone, gray, crystalline, calcarenitic, nodular; lower 6 in. with shale partings every 1-2 in.; top 6 in. a single bed. (1 ft)
15. Shale, brown to green, calcareous. (2 in.)
14. Limestone, gray, medium-grained calcarenite, fossiliferous (ostracodes); very irregular, wavy beds. (4-6 in.)
13. Shale, gray-green, fissile; thin limestone lenses. (1 ft)
12. Limestone, light-gray, finely crystalline to sublithographic. (2 in.)
11. Shale, gray-green, platy to fissile. (3 in.)

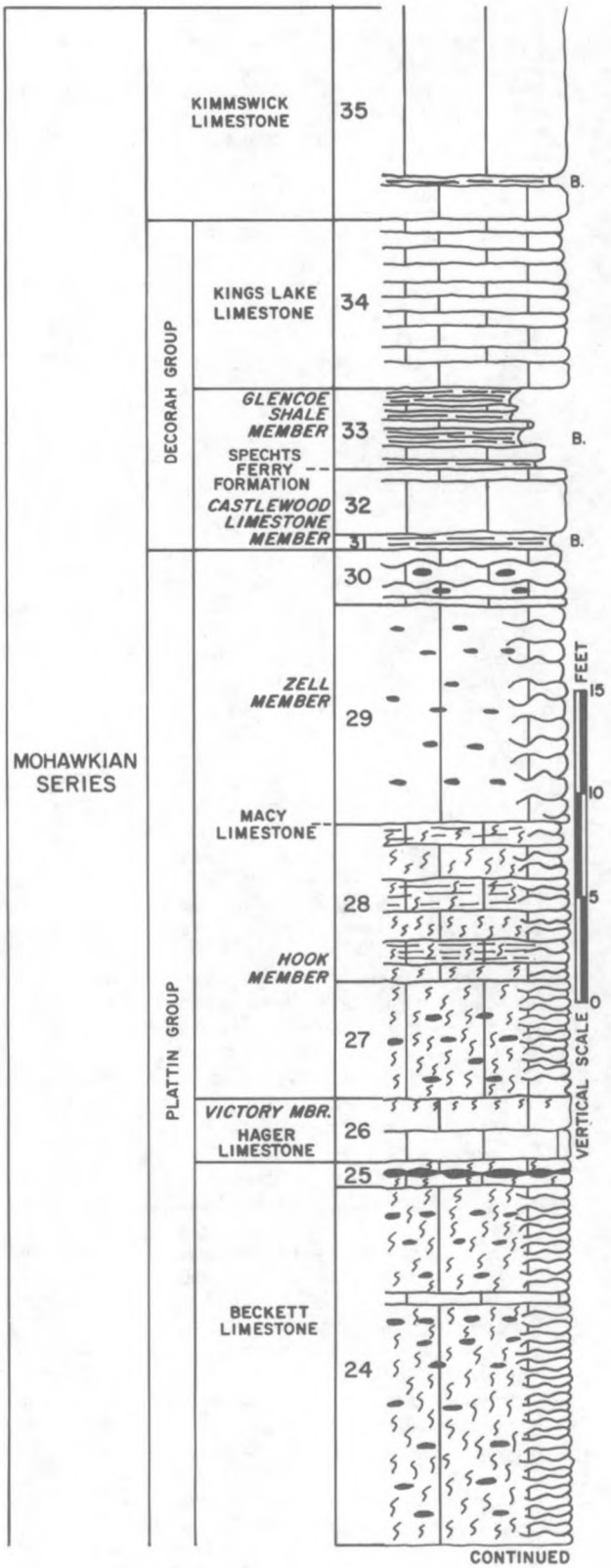
Brickeys Member (12 ft 8 in.)

10. Limestone, like no. 8. (1 ft)
9. Dolomite, brown, earthy; forms reentrant; lower half of nos. 9-10 transitional unit. (8 in.)
8. Limestone, gray to brown, finely crystalline to sublithographic, dense; top 6 in. blocky, laminated, "algal." (1 ft 8 in.)
7. Shale and limestone; alternating 2-in. blue-green shale with 2-in. beds of light gray, lithographic limestone; 3 shales and 2 limestones. (10 in.)
6. Limestone, light-gray, lithographic, very fossiliferous, "algal." (6 in.)
5. Limestone, chocolate-brown, lithographic; 2 beds, lower 2 ft 3 in., upper 10 in.; lower 6 in., with "birdseye" structures, transitional with no. 4; poorly developed calcite crystals in upper beds. (3 ft)
4. Dolomite, green-gray, calcareous; "birdseye" structures; lower half shaly, fissile; upper half blocky; forms reentrant. (1 ft 6 in.)
3. Limestone, light-gray, lithographic; scattered calcite crystals (1 in. and smaller); single bed, weathers to 0.25-0.5 in. incipient nodular beds. (1 ft)
2. Limestone, light-gray, laminated; lower 6 in. fine- to medium-crystalline, becoming sublithographic upward; scattered oolites in lower 6 in. (2 ft 6 in.)

Joachim Dolomite (6 ft +)

1. Dolomite, tan, laminated, mottled "birdseye" structures; top irregular. (6 ft+)

Base at road level.



Units 27-34 were measured at the west end of the east cut, north side of north frontage road to I-44, west of entrance to Six-Flags amusement park. Top of Victory Member is in base of cut on frontage road. Units 24-26 were measured on the east roadcut (north side) of I-44. Units 1-23 were measured in the western roadcut (north side) of I-44.

ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Kimmswick Limestone

35. Limestone, light gray, medium- to coarsely crystalline, thick-bedded; **House Springs K-bentonite Bed.** (15 ft+)

DECORAH GROUP

Kings Lake Limestone (8-10 ft)

34. Limestone, gray to light-gray, very finely crystalline; in thin slabby beds; very fossiliferous. (8-10 ft)

Spechts Ferry Formation

Glencoe Shale Member (2 ft 5 in.)

33. Shale, green; interbedded dark purple, very fossiliferous limestone coquina; **Millbrig K-bentonite Bed.** (6-8 in.)

Castlewood Limestone Member (3 ft 6 in.)

32. Limestone, gray, very finely crystalline to lithographic; even textured; top a dark-purple 0.5- to 1-in. coquina, like no. 33. (3 ft)
31. Shale, brown and green, clayey; **Deicke K-bentonite Bed.** (6 in.)

***PLATTIN GROUP* (120 ft)**

Macy Limestone (25 ft 6 in.)

Zell Member (12 ft 6 in.)

30. Limestone, brown, lithographic, coarsely burrowed, cherty; irregular, wavy beds; base at continuous 2-in. limestone bed. (2 ft 6 in.)
29. Limestone, sublithographic, argillaceous, unburrowed; some "birdseye" structures; scattered calcite crystals in upper part; blue-gray chert nodules; single, shattered bed; abrupt contact with no. 28. (10 ft)

Hook Member (13 ft)

28. Limestone, like no. 27; basal 4 in. laminated, unburrowed, above 1-2 in. burrowed zone; scattered chert; more argillaceous toward top; alternating argillaceous and purer limestone beds 1-2 ft thick. (7 ft 6 in.)
27. Limestone, light-gray, finely crystalline to sublithographic, highly burrowed (0.25-0.5 in.); scattered brown chert nodules; top at prominent bedding plane. (5 ft 6 in.)

Hager Limestone (3 ft)

Victory Member (3 ft)

26. Limestone, very light-gray, laminated, lithographic; no burrows except in top 6 in.; prominent marker in cut; abrupt top and base. (3 ft)

Beckett Limestone (90 ft)

25. Limestone, laminated, burrowed; chert between 2-ft limestone beds; weathers shaly. (10 in.)
24. Limestone, very light-gray, sublithographic, highly burrowed, prominent unburrowed calcarenite bed 4 ft 10 in. below top; density of burrowing increases upward in unit; brown chert nodules in top 1 ft (5%-10%); base approximately at top of no. 23 in western-most cut on I-55. (17 ft 6 in.)

Figure 72. **Plattin and Decorah Groups** *exposed in a roadcut on I-44 and the adjacent north frontage road, just west of the Allenton-Six Flags exit, sec. 33, T. 44 N., R. 3 E., St. Louis County, east-central Missouri, Eureka 7½' Quadrangle. Described by T.L. Thompson, 1986.*

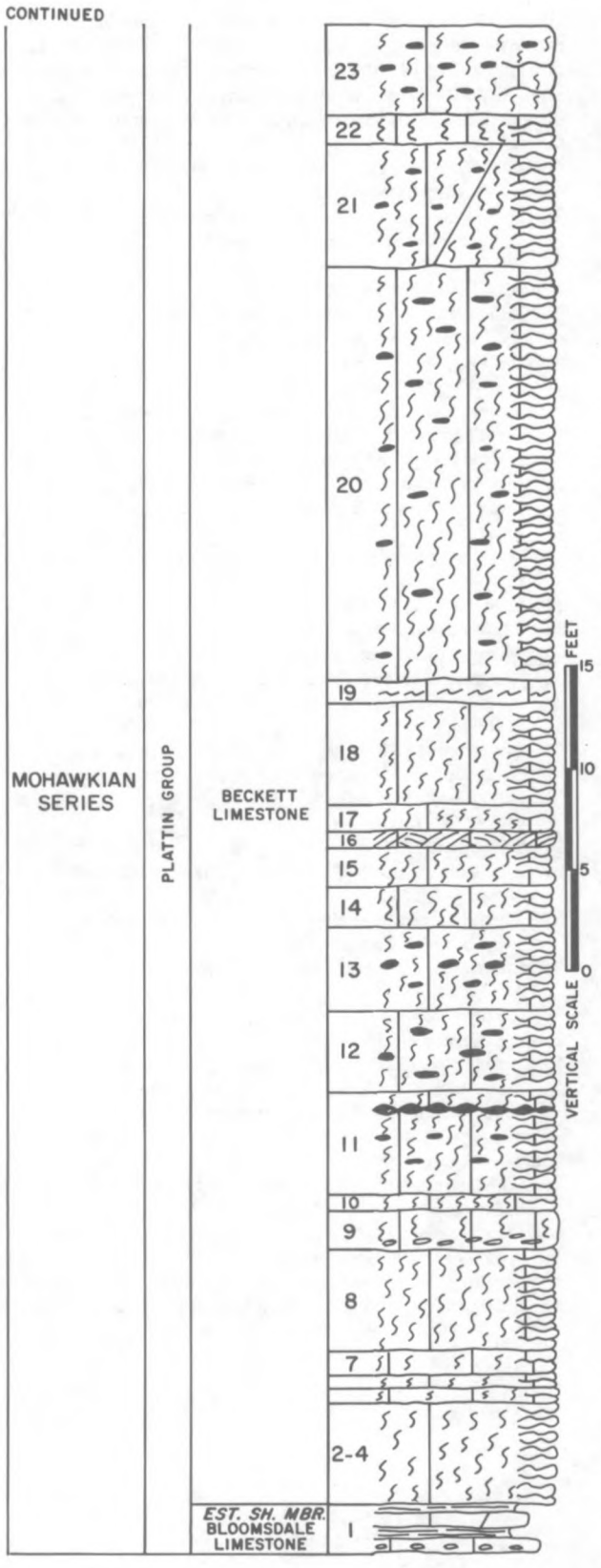


Figure 72 (cont.)

23. Limestone, very light-gray, lithographic, massive, thick-bedded, heavily burrowed; black burrow-filling; scattered chert nodules. (4-5 ft)
22. Limestone, light-gray, sublithographic; 0.5-1-in. burrows; white chert in upper part. (1 ft 6 in.)
21. Limestone, brown, heavily burrowed; burrows dolomite-filled. (6 ft)
20. Limestone, light-gray to brown, medium-grained calcarenite to sublithographic, algal, highly burrowed, disturbed, very fossiliferous; some white chert; measured at east end of west cut on north side of I-44, top of bench. (20 ft)
19. Limestone, light-gray; horizontal burrowing filled with medium-grained calcarenite; large calcite crystals in lower 3 in.; single bed. (1 ft 3 in.)
18. Limestone, light-gray, sublithographic, burrowed (0.25-0.5 in.); hackly bedding. (5 ft)
17. Limestone, coarsely crystalline to sublithographic, burrowed; no chert. (1 ft 4 in.)
16. Limestone, light-gray, argillaceous, laminated to cross-laminated; very fine-grained calcarenite; no burrowing; no chert. (10 in.)
15. Limestone; like no. 14.
14. Limestone; like no. 13; not quite as heavily burrowed; some 0.5-1 in. horizontal burrows; no chert. (2 ft 2 in.)
13. Limestone, light-gray, lithographic; darker burrow-filling than no. 12; 0.25-0.5 in. burrows, more circular in cross-section than in no. 12; some chert in lower 1 ft; appears browner from a distance than rocks above. (1 ft 2 in.)
12. Limestone, gray to gray-brown, sublithographic, finely crystalline, heavily burrowed; chert as large 1-2-in. discontinuous nodular beds; single bed. (4 ft 6 in.)
11. Limestone, gray to brown, sublithographic, heavily burrowed; a few thin calcarenite beds; hackly incipient bedding; chert as scattered brown nodules smaller than in no. 12; one continuous 0.5 in. chert bed 8 in. below top of unit; top at stylolite. (5 ft)
10. Limestone, gray-brown, fine- to medium-crystalline, heavily burrowed (0.25-0.5 in.); zones of vertical burrowing; single bed welded to top of no. 9. (8 in.)
9. Limestone, light-gray to blue-gray, fine- to coarse-grained calcarenite, porous, highly disturbed, burrowed (0.5-1 in.); pebble conglomerate; zones of bluish mudstone; appears algal on joint face; prominent bed on fresh face. (2 ft)
8. Limestone, gray, mottled, fine- to medium-crystalline, fossiliferous; 0.25-0.5-in. burrows; massive bed; top at bedding plane below algal zone of no. 9. (5 ft)
7. Limestone, light-gray to gray-brown, sublithographic to finely crystalline; burrowing not obvious, but present; top at color change on west edge of cut; prominent bedding plane in middle. (1 ft 4 in.)
6. Limestone, light-gray, lithographic, vertical burrows, some areas appear unburrowed; top at prominent bedding plane; thins eastward and becomes lowest unburrowed bed. (6 -8 in.)
5. Limestone, light-gray; highly burrowed lower 3 in.; middle 3 in. unborrowed fossiliferous calcarenite; top 3 in. burrowed; units vary laterally. (8 in.)
4. Limestone, gray, fine- to medium-crystalline; more lithographic upward; hackly, incipient bedding; heavily burrowed with 50% dolomite-filling by volume; laterally changes to resemble no. 2; no. 3 becomes a bedding plane. (5 ft 6 in)
3. Limestone, coarse-grained calcarenite; thin bed between two hackly lithographic limestone beds. (0-3 in.)
2. Limestone, light-gray, lithographic; "hackly," incipient, wavy bedding; 0.25-0.5-in. dolomite-filled burrows. (1 ft 2 in.)

Bloomsdale Limestone

Establishment Shale Member

1. Limestone, gray-tan, dolomitic, silty; two beds, upper bed with brown "birdseye" structures in upper part; lower bed brown, medium-crystalline; 4-6 in. slabby to shaly beds between upper and lower limestone beds; pebble conglomerate; base at I-44 level. (2 ft 6 in. exposed)

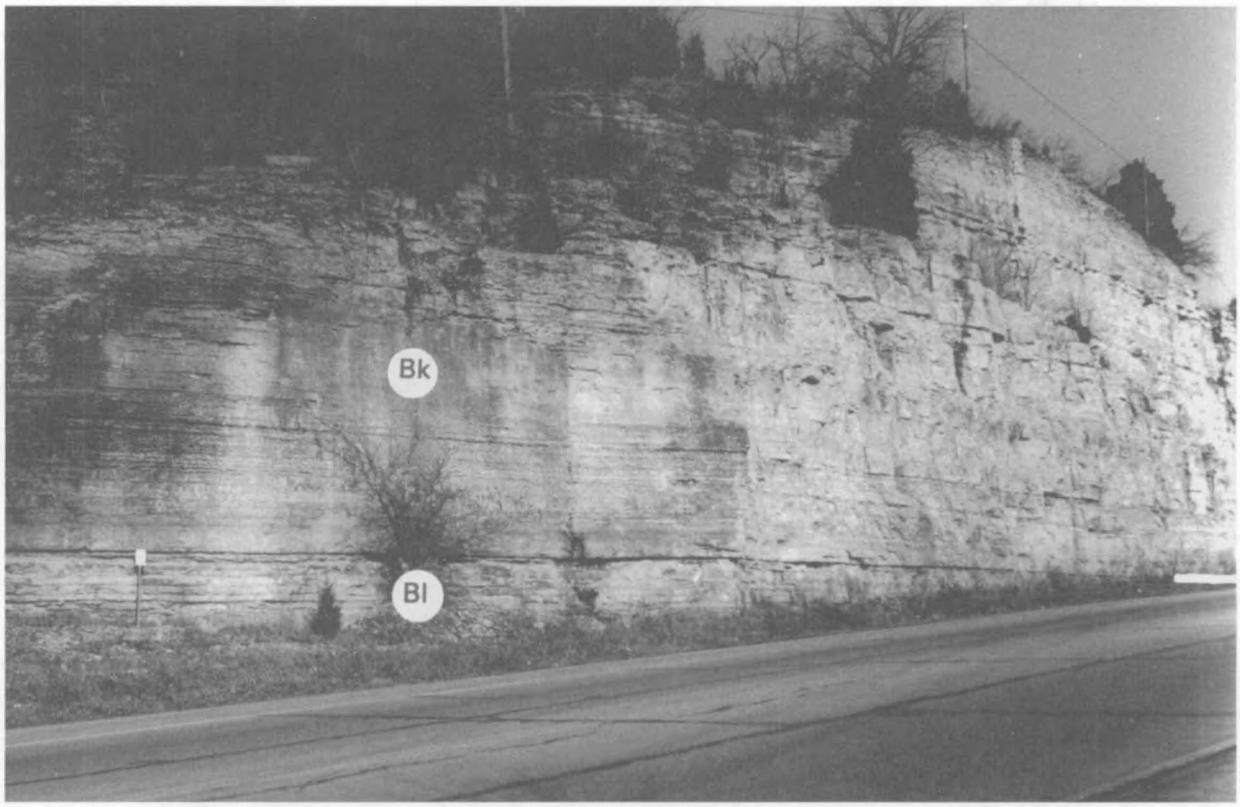


Figure 73. *Lower part of the* **Plattin Group** *in a roadcut on Loop 44, S½ N½ sec. 4, T. 43 N., R. 3 E., Pacific 7½' Quadrangle, 0.5 mi south of fig. 72. The Brickeys and Establishment Shale Members of the Bloomsdale Limestone* **(Bl)** *and Beckett Limestone* **(Bk)** *are exposed. Photograph by Myrna Rueff.*

Figure 74 (illustration on next page)

ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
***PLATTIN GROUP* (60 ft)**
Macy Limestone (13 ft)
Hook Member
35. Limestone, gray, lithographic to fine-grained calcarenite; 0.25-0.5-in. and 0.5-1-in. burrows; to top of exposure. (6 ft.)
34. Limestone, gray-brown, finely crystalline, heavily burrowed (0.25-0.5 in. to greater than 0.5 in.); burrows denser in lower third. (2 ft 4 in.)
33. Limestone, dark-gray, lithographic with widely dispersed thin beds of medium-grained calcarenite, fossiliferous; large 1-in. calcite crystals in lower part; incipient 1-2-in. wavy beds from large weathered 1-2-in. burrows, incipient beds thicker than in units below; does not weather hackly; distinct color change from no. 32. (3 ft)
32. Limestone, gray, alternating lithographic and fine-grained calcarenite; 0.5-in. horizontal burrows; upper 8-in. bed fossiliferous; separated from lower 6-in. bed by shale parting; scattered chert nodules in upper half. (1 ft 2 in.)
31. Limestone, dark-gray, lithographic; closely spaced 0.25-0.5-in. burrows; very hackly beds; top irregular. (6 in.)

Hager Limestone (9 ft 4 in.)
Victory Member (10 in.)
30. Limestone, light-gray, lithographic; vertical 0.25-in. wide burrows in top 2 in.; top irregular; two beds; lower 3-in. bed argillaceous, burrowed, upper 7-in. bed lithographic, dense. (10 in.)

Hely Member (1 ft 8 in.)
29. Limestone, dark-gray, lithographic; 0.25-0.5-in. burrows; two even beds: 1 ft 10 in. and 10 in. (1 ft 8 in.)

Glaize Creek Member (5 ft)
28. Limestone, light-gray, fine-grained calcarenite at base, grading upward to lithographic; unburrowed at base grading upward to sparsely burrowed in upper half; base irregular; top like no. 26, with some vertical burrows; top at prominent bedding plane **(Clement grainstone facies)**. (8-10 in.)
27. Limestone, gray to light-gray; fine-grained calcarenite with lenses of lithographic; 0.25-in. wide vertical burrows; top uneven, base even **(Clement grainstone facies)**. (2-4 in.)
26. Limestone, light-gray, lithographic, unburrowed; some silt; no "birdseye" structures; some calcite crystals (like no. 24); base weathers to 0.25-in. shale seam. (1 ft)
25. Limestone, dolomitic, silty, laminated; top at thin shale bed. (5 in.)
24. Limestone, light-gray, lithographic, unburrowed; conchoidal fractures, scattered "birdseye" structures; single bed when fresh, weathers to 3 uneven beds (3-5 in., 5 in., and 6 in.); top and base even. (1 ft 6 in.)
23. Limestone, light-greenish-gray, fine-grained calcarenite, burrowed; pebble conglomerate in upper part; incipient wavy beds in lower part; stylolitic at top. (1 ft)
22. Shale, gray-green, wavy. (0.5-1 in.)

Hely Member (1 ft 8 in.)
21. Limestone; upper part dark-gray, lithographic, with 0.25-0.5-in. burrows; lower part lithographic, with large 0.5-1-in. horizontal burrows, white chert nodules, and calcite crystals. (1 ft 6 in.)
20. Shale, brown, calcareous, platy (K-bentonite bed ?); lower half clayey. (2-3 in.)

Beckett Limestone (26 ft 8 in.)
19. Limestone, dark-gray, lithographic; 0.5-1-in. horizontal burrows in lower 3 ft 6 in.; bed of discontinuous white chert nodules 1-ft above base; a few widely scattered calcite crystals in upper part; weathers like below (no. 16). (6 ft)

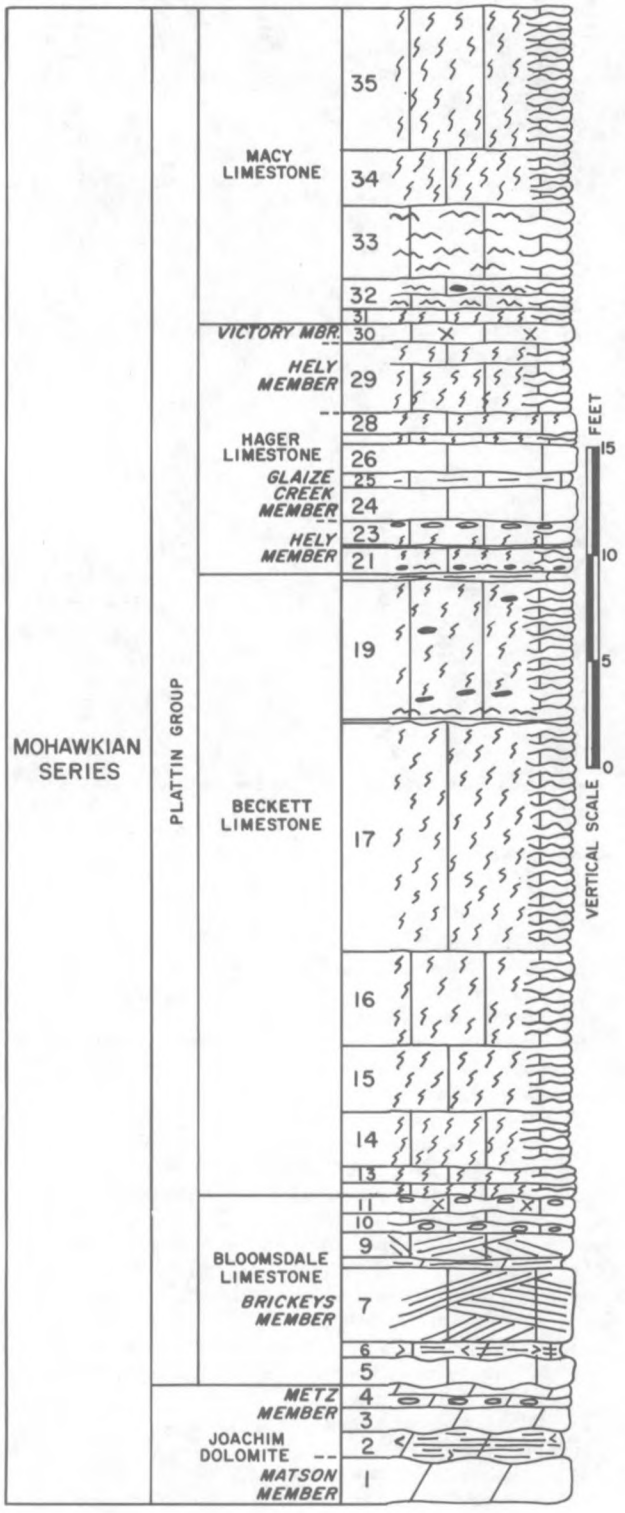


Figure 74 (cont.)

18. Limestone, light-gray, very highly burrowed; burrows 0.25-0.5-in. wide; appears conglomeratic; irregular top; about 1 ft below bed of chert nodules in no. 19; stylolitic. (4 in.)
17. Limestone, gray to dark-gray, highly burrowed (0.25-0.5 in.); even 4-10-in. beds with hackly bedding planes. (10 ft)
16. Limestone, gray, lithographic, highly burrowed; very nodular, weathered face; (0.25-0.5 in.); weathers to 1-3 in. pitted beds; top at prominent bedding plane. (4 ft)

Beds 16-35 exposed on Highway F. Beds 1-15 were measured from gravel road at bridge heading north from F.

15. Same as no. 14; even 4-6-in beds with incipient hackly bedding in lower half; top is top of cut at south end, near junction; 15 ft+ of limestone is exposed above in center of cut. (3 ft)
14. Limestone, light-gray, lithographic, heavily burrowed; burrow-filling also gray, hard to see; incipient 0.5-1-in. wavy beds between prominent bedding planes. (2 ft 6 in.)
13. Limestone, dark-gray, lithographic; some finely crystalline calcarenite; 0.25-0.5-in. burrows with light gray filling; top at prominent bedding plane. (9 in.)

Units 9-12 are between fresh bedding planes; 12-13 are one unit on fresh face, which weathers to a single massive bed at the northeast corner.

12. Limestone, light-gray, fine-grained calcarenite with small sublithographic lenses; irregular stylolite at top; base on thin shale; incipient nodular 1-2-in. beds. (6 in.)

Bloomsdale Limestone (10 ft 6 in.)

Brickeys Member (10 ft 6 in.)

11. Limestone, bluish-brown to grayish-brown, fine-grained calcarenite; pebble conglomerate in upper 3 in.; base irregular on no. 10; upper 0.5-1 in. slabby. (7-11 in.)
10. Limestone, light-brown, laminated; lower half pure, with pebble conglomerate at base; upper half argillaceous, with "birdseye" structures; top slightly irregular. (6-9 in.)
9. Limestone, light-gray, lithographic; black "birdseye" structures; lower 3 in. argillaceous, fine-grained, cross-laminated calcarenite. (1 ft 1 in)
8. Shale, greenish-tan, platy, silty; dolomitic brown "birdseye" structures; lenses of 1-2 in. limestone in lower part; top irregular. (3-6 in.)
7. Limestone; lower half dark-gray, fine-grained, cross-laminated calcarenite; upper half chocolate-brown, sublithographic; pebble conglomerate in lower part; "birdseye" structures in middle part; irregular base; upper beds regular. (3 ft 2 in.)
6. Shale, tan, dolomitic, platy to fissile; brown "birdseye" structures; irregular base. (6-10 in.)
5. Limestone; lower 6 in. grayish-tan; upper 1 ft purple-gray; very irregular base; single bed. (1 ft 6 in.)

Joachim Dolomite (5 ft 6 in.)

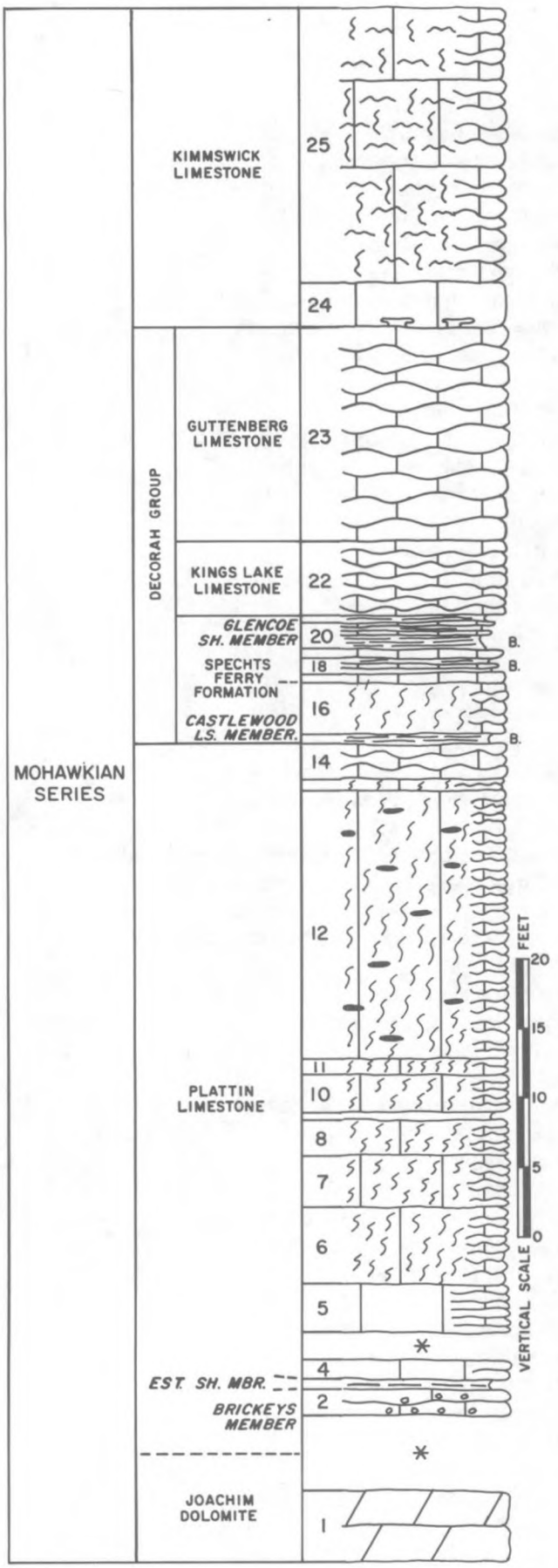
Metz Member (3 ft 6 in.)

4. Dolomite, tan, dense, hard; two beds: lower 5 in. (pebble conglomerate) and upper 6-10 in.; top very irregular. (6 in. to 1 ft 4 in.)
3. Dolomite, tan, soft, irregular; brown "birdseye" structures. (1 ft)
2. Dolomite, shaly, platy, silty. (1 ft 2 in.)

Matson Member (2 ft)

1. Dolomite, brown, vuggy; very irregular top; in road ditch at base of lower exposure. (2 ft)

Figure 74. **Plattin Group** *exposed in roadcuts on St. Charles County road F and on a side road to F, at the bridge over the Femme Osage River, 1.5 mi northwest of Defiance, SW¼ NE¼ SE¼ sec. 21, T. 45 N., R. 2 E. (see figs. 81B and 96A). Described by T.L. Thompson, 1986.*



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Kimmswick Limestone (17 ft 6 in. - 22 ft 6 in.)

25. Limestone, light-gray, coarsely crystalline, dense, thick bedded, heavily burrowed. (15-20 ft)
24. Limestone, brown, finely crystalline; welded contact with no. 23; single bed; top 6 in. medium crystalline. (2 ft 6 in.)

DECORAH GROUP (26 ft 4 in.)

Guttenberg Limestone (14 ft)

23. Limestone, very light-gray, lithographic, very fossiliferous; nodular 3-6 in. beds separated by darker gray, shalier 0.5-1-in. zones; scattered small nodules of light-tan chert; beds slabbier toward top. (14 ft)

Kings Lake Limestone (5 ft)

22 Limestone, gray, sublithographic, very fossiliferous; as thin nodular to slabby beds separated by dark gray shale partings; bedding thinner than in overlying Guttenberg; a few calcarenite beds. (5 ft)

Spechts Ferry Formation (7 ft 6 in.)

Glencoe Shale Member (4 ft)

21. Shale, dark-gray, calcareous. (6 in.)
20. Shale and limestone; basal 8 in. shale (includes **Elkpoint K-bentonite Bed**); alternating 1-2-in. beds of limestone and shale. (1 ft 6 in.)
19. Limestone, lithographic; single bed. (8 in.)
18. Shale and limestone; three shale partings and two to three lithographic limestone beds (includes **Millbrig K-bentonite Bed**). (8 in.)
17. Limestone, lithographic to medium-crystalline, fossiliferous, unburrowed; single bed. (8 in.)

Castlewood Limestone Member (3 ft 6 in.)

16. Limestone, gray, sublithographic, dense, very fossiliferous, burrowed; essentially one bed, with wavy shale partings forming incipient 3-10-in. nodular beds. (3 ft.)
15. Shale, brown, clayey **(Deicke K-bentonite Bed)**. (6-8 in.)

Plattin Limestone (42 ft)

14. Limestone, lithographic, unburrowed; thick 3-5-in. nodular beds; prominent. (2 ft)
13. Limestone; very wavy, incipient bedding; top at base of even lithographic bed. (10 in.)
12. Limestone, lithographic; burrowed like nos. 10-11; weathers slabby; scattered small brown chert nodules; top at thin calcarenite. (18 ft)
11. Limestone, light-gray, highly burrowed; single bed. (1 ft)
10. Limestone; like no. 8; burrowed; very irregular shale partings; single bed. (2 ft 6 in.)
9. Shale, brown, clayey. (4-6 in.)
8. Limestone, light-gray, lithographic, highly burrowed; single bed. (2 ft 6 in.)
7. Limestone; interbedded lithographic and calcarenitic; horizontal 0.25-0.5 in. burrows in lithographic (50%), like no. 6; thin, slabby beds. (3 ft)
6. Limestone, light-gray, lithographic, silty, highly burrowed; calcarenite zones in base of a few beds; weathers slabby, with incipient wavy shale partings. (5 ft)
5. Limestone, calcarenitic; dense to slabby, nodular, wavy beds; lenses of light-gray lithographic limestone. (3 ft)
4. Limestone, light-gray, sublithographic, dense; exposed below farm-field road (east-side). (1 ft 6 in.)

Establishment Shale Member (2 in.)

3. Shale parting. (2 in.)

Brickeys Member (?)

2. Limestone, brown, oolitic; only top exposed in ditch below farm-field road. (?)

Joachim Dolomite

1. Dolomite and interbedded dolomitic limestone; in ditch to river level. (30 ft +)

Figure 75. ***Plattin Limestone*** *and* ***Decorah Group*** *exposed in a roadcut on U.S. Highway 61, just north of the bridge over Spencer Creek, SE¼ SE¼ sec. 21, T. 55 N., R. 4 W., Ralls County, northeastern Missouri. From a description by T.L. Thompson, 1986.*

History of nomenclature

1855	Swallow	Black River Limestone
		Birds-eye Limestone
1873	Broadhead	Black River limestone
	Pumpelly	Trenton limestone
		Black River limestone
	Shumard	Black River limestone
		Birds-Eye limestone
		McPherson marble of Birds-Eye limestone
	Potter	Black River - Birds-Eye limestones
1874	Broadhead	Trenton limestone
		Black River limestone
		Birds-Eye limestone
1891	Penrose	Izard limestone (upper part)
	Rowley	Trenton limestone (lower part)
1898	Keyes	Bryant or Trenton limestone
	Marbut	Trenton limestone (lower part)
1900	Gallaher	Black River limestone
1904	**Ulrich**	**Plattin limestone** (lower part; included Decorah)
1908	Rowley	Auburn chert beds
1912	Willis	Plattin limestone
1915	Keyes	Bryant limestone
1920	Foerste	Plattin limestone
		Auburn chert
1921	Dake	Plattin limestone
1923	Keyes	Bryant limestone (rejected "Plattin")
1925	Bradley	Plattin limestone (Black River in age; "Bryant or McCune limestone of Keyes, 1898"; part)
1928	**Weller and St. Clair**	**Plattin limestone** (restricted to present definition; named overlying Decorah Formation)
1934	Randall	Auburn chert
	Gries	"Blackriver forms from southeastern Missouri"
1937	McQueen	Plattin formation
	Keyes (a)	Bryant limestone
	Keyes (b)	Beloit limestone (upper part)
1939	McQueen	Plattin formation (Black River group)
	Ulrich	Plattin limestone
		Lebanon limestone ("of Tennessee")
1951	Larson	Plattin group
		Macy limestone
		Zell limestone member
		Hook limestone member
		Hager limestone
		Beckett limestone
		Bloomsdale formation
1954	Twenhofel et al.	Plattin group (Plattin limestone)
		Macy limestone
		Hager limestone
		Beckett limestone
		Bloomsdale limestone
1961	Martin et al. (a)	Plattin formation
1963	Templeton and Willman	Plattin Subgroup of Platteville Group
		Quimbys Mill Formation (3 members)
		Nachusa Formation (3 members)

		Grand Detour Formation (7 members) Mifflin Formation (5 members)
1966	Echols and Levin	Plattin Limestone
1976	Shourd and Levin	Plattin Sub-Group (upper part) Quimby's Mill Nachusa Grand Detour Mifflin
1977	Thacker and Satterfield	Plattin Formation Establishment Shale
1978	Willman and Kolata	Plattin Subgroup of Platteville Group Quimbys Mill Formation (3 members) Nachusa Formation (3 members) Grand Detour Formation (2 members) Mifflin Formation (no members)
1982	Thompson	Plattin Limestone
1986	McCart	Plattin Subgroup of Platteville Group Macy Formation Hager Formation Victory Member Hely Member Clement Member Beckett Formation Bloomsdale Formation
1987	Thompson	Plattin Formation Establishment Shale Member
1991	**Thompson (present report)**	**Plattin Group** (east-central and southeastern Missouri) **Macy Limestone** **Zell Member** **Hook Member** **Hager Limestone** **Victory Member** **Hely Member** **Glaize Creek Member** **Beckett Limestone** **Bloomsdale Limestone** **Establishment Shale Member** **Brickeys Member** **Blomeyer Member** (southeastern Missouri only) **Plattin Limestone** (northeastern outcrop and subsurface in Missouri) **Establishment Shale Member** **Brickeys Member**

Remarks -- Nomenclature of the Plattin succession in Missouri can be treated in two ways: (1) as the **Plattin Limestone**, when studied as a single unit, as in some mapping projects, in northeastern Missouri outcrops, in much of the subsurface of Missouri, and when more detail either is not available or is not needed; and (2) as the **Plattin Group**, comprising four formations, in ascending order, the Bloomsdale, Beckett, Hager, and Macy Limestones, which are exposed in eastern and southeastern Missouri. Although identified as Plattin Group in most of the following discussion, the "group" can be considered to be a "formation" (Plattin Limestone), if the worker so desires.

The Plattin Group, 45-400 ft thick (fig. 76), is typically a succession of sparsely cherty gray to light-gray nodular-bedded mudstones interbedded with thinner beds of grainstone; it can also be characterized as

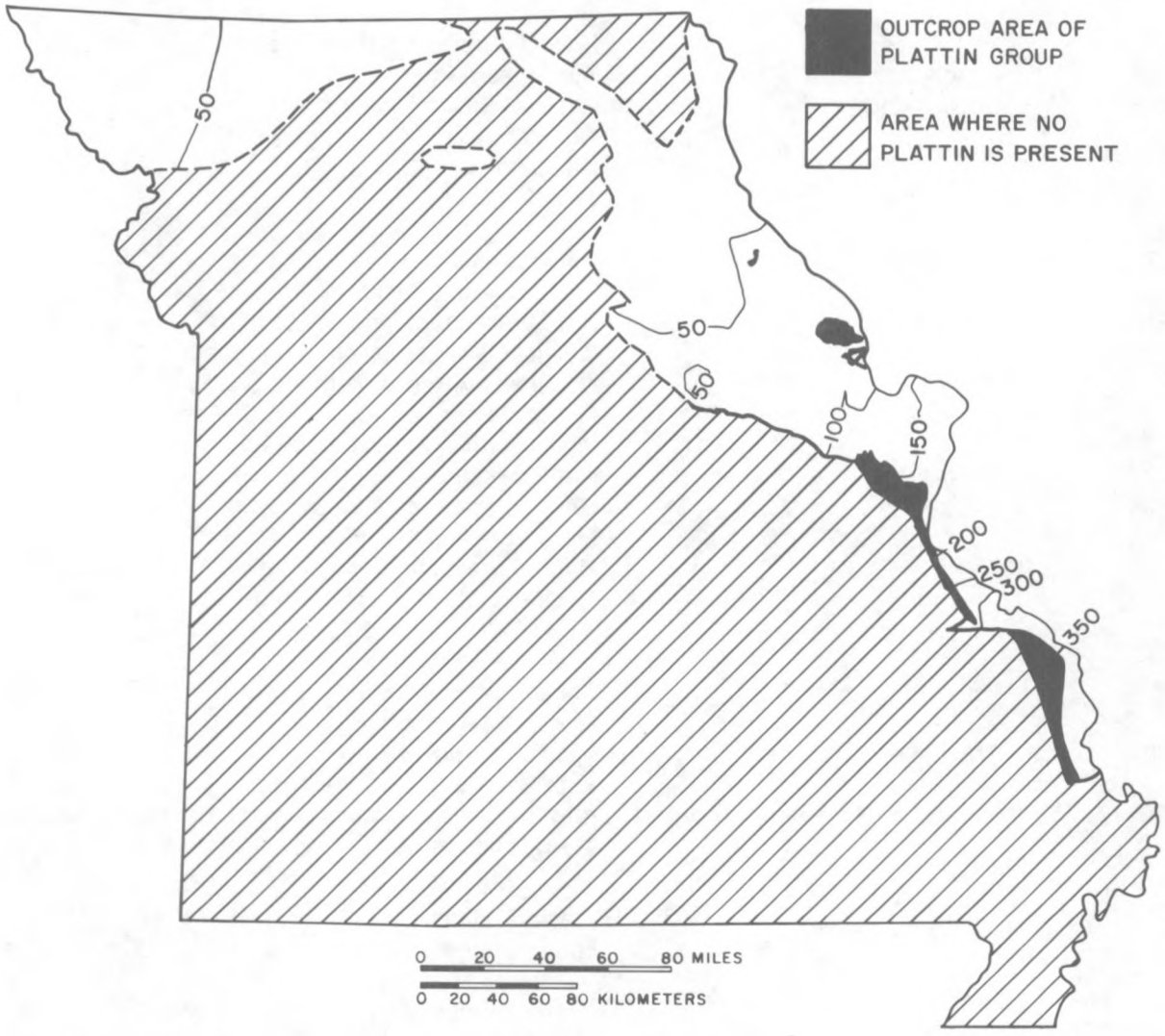


Figure 76. *Isopach map, distribution, and areas of outcrop of formations of the* **Plattin Group** *in Missouri. Isopach interval is 50 ft.*

a burrowed ("fucoidal") mudstone interbedded with unburrowed laminated to cross-laminated thin grainstone beds, which are more abundant in the upper half. Some beds are abundantly fossiliferous; others are quite barren. A distinctive sequence of unburrowed light-gray to white fine grainstone to mudstone (**Glaize Creek** and **Victory Members of the Hager Limestone**), one-half to two-thirds above the base of the Plattin, serves as a marker for division of the Plattin Group in east-central and southeastern Missouri. The **Glaize Creek Member** is proposed in this report, and the concept of three members, Glaize Creek, Hely, and Victory, for the Hager Limestone is also proposed here, and independently by McCart (1986). The burrows, ranging from 0.25 in. to as much as 2 in. in diameter, are commonly filled with medium- to finely crystalline brown to tan dolomite, but fill material may also be very light gray to dark gray. A characteristic feature of the limestones of the Plattin (especially the Beckett and Macy Limestones) is the "honeycomb," or pitted, nature of the weathered surface (fig. 77); the burrow fillings weather out, resulting in highly pitted, slabby-bedded limestone ledges.

The basal 10-25 ft of the Plattin (**Brickeys Member of the Bloomsdale Limestone**) differs from the overlying burrowed beds. It is a distinctive brown to chocolate brown mudstone and oolitic grainstone, interbedded with thinner beds of dolomitic limestone and dolomite, the latter often containing "birdseye"

Figure 77. *Typical appearance of weathered burrowed limestone of the* **Plattin Group** *(Beckett Limestone); interchange of Jefferson County road M with I-55 at Barnhart, SE¼ NW¼ sec. 30, T. 42 N., R. 6 E., Jefferson County, Missouri. Photograph by T.L. Thompson.*

structures. Pebble conglomerates are common in the limestone beds, which are generally unburrowed. A thin but prominent shale (**Establishment Shale Member of the Bloomsdale Limestone**) separates the Brickeys Member from the overlying "typical Plattin" Beckett Limestone in east-central and southeastern Missouri.

Because it is a purer calcium carbonate, is oolitic, and contains pebble conglomerates, the basal unit of the Plattin, the **Brickeys Member of the Bloomsdale Limestone**, can be distinguished from the underlying Joachim Dolomite. The Joachim-Brickeys contact is usually disconformable, irregular, or wavy (fig. 70A). In Cape Girardeau and Scott counties, the basal oolite of the Brickeys is separated from the underlying "Pecatonica Formation" by the **Blomeyer Member of the Bloomsdale Limestone**, which is restricted to that region. The base of the overlying Decorah Group, a "K-bentonite" (potassium-rich, 80 percent illite - 20 percent smectite; Dennis R. Kolata, Illinois Geological Survey, personal communication, 1986; "bentonites" are high in smectite) and limestone overlain by fossiliferous shale and limestone beds in eastern Missouri (Castlewood Limestone and Glencoe Shale Members of the Spechts Ferry Formation), is more argillaceous than the Macy Limestone of the Plattin Group, and is faunally distinct. Both upper and lower contacts of the Plattin Group are regarded as disconformable.

Grohskopf (1948) noted that the limestones are very uniform in appearance throughout most of the Plattin. Martin et al.(1961a, p. 27) stated,

> "The Plattin consists of evenly bedded, dark gray, finely crystalline to sublithographic limestone which contains minor amounts of intercalated shale. The basal unit is easily recognized because it is composed of a pebble conglomerate and oolite and contains shale and ostracodes...Thin metabentonite beds are present in the upper part of the Plattin. Brown, dark gray, and white chert nodules and layers are present throughout most of the formation...

"The Plattin thins to less than 100 feet in Ralls and Montgomery Counties. Northward and westward from Cape Girardeau County, it is approximately 450 feet thick."

Koenig and Martin (1961, p. 16) added,

"In Clark County in extreme northeastern Missouri, 25 feet of dolomite were logged as Plattin. North and west of Knox County the Plattin apparently is absent."

Two recent studies divided the Plattin succession in Missouri. Larson (1951) divided the "Plattin Group" of southeastern Missouri into four formations, all named from type sections in Missouri (fig. 78); they are described in detail below. Templeton and Willman (1963, p. 78) defined the "Plattin Subgroup of the Platteville Group" of Illinois and surrounding states (including eastern Missouri) as also comprising four formations (but not the same formations described by Larson); each formation is divided into members (fig. 78). The various units were differentiated on thickness of bedding, degree of burrowing of the carbonates, percentage of dolomitization, fossil content, etc. They are the following:

Top of Plattin Subgroup
Quimbys Mill Formation
  Strawbridge Member
  Shullsburg Member
  Hazel Green Member
Nachusa Formation
  Everett Member
  Elm Member
  Eldena Member
Grand Detour Formation
  Forreston Member
  Victory Member
Grand Detour (cont.)
  ***Hely Member**
  ***Clement Member**
  Stillman Member
  Walgreen Member
  Dement Member
Mifflin Formation
  Briton Member
  Hazelwood Member
  ***Establishment Member**
  ***Brickeys Member**
  ***Blomeyer Member**
Top of Joachim Dolomite

* indicates units named from type sections in Missouri

Templeton and Willman stated (p. 73),

"Except for the Blomeyer, Brickeys, and Establishment Members of the Mifflin Formation, the Platteville units herein described were differentiated in the northern outcrop area prior to Larson's study and were traced independently to southern Illinois and eastern Missouri...Although use of Larson's nomenclature in Illinois has been carefully considered, we prefer the classification developed in the northern outcrop area because (1) it divides the sequence into formational units that are more natural from a regional point of view, and because (2) it recognizes as members distinctive units that Larson combined."

This classification was established for the Illinois Basin; the Plattin in Missouri is on the western edge, or shelf, of this basin. Named from a succession of dolomites or dolomitic limestones in northern Illinois and southern Wisconsin, this succession comprises very pure limestones in Missouri. Thus, in Missouri, distinction between Templeton and Willman's formations is very difficult, because lithologic characteristics are nearly, if not completely, identical. In addition, characteristics that identify these units, originally defined from old, naturally-weathered exposures, do not appear to be manifest on newer exposures, such as roadcuts and quarry faces, a factor that complicates attempts to use Templeton and Willman's classification.

To further complicate usage of this scheme in Missouri, all members may not be present at any one section. Extensive field work by the author of the present report has determined that if one or more of the members is absent, identification of most of the others can be nearly impossible, an observation verified by other geologists (D. R. Kolata, Illinois Geological Survey, personal communication, 1986).

Willman and Kolata (1978, p. 28) discovered similar problems in their study of "Middle Ordovician" strata in northern Illinois (fig. 78). They stated that

"...[a] somewhat thicker bedded, less shaly zone within the Mifflin [was] used...as the basis for differentiation of three members including the Establishment (lower, shaly member), Hazelwood (middle, thick-bedded member) and Briton (upper, thin-bedded member). The threefold differentiation has been found to be unrecognizable in many exposures and generally too indistinct to be useful. In addition, some confusion has resulted from miscorrelation of the Hazelwood Member at the type section. The possible

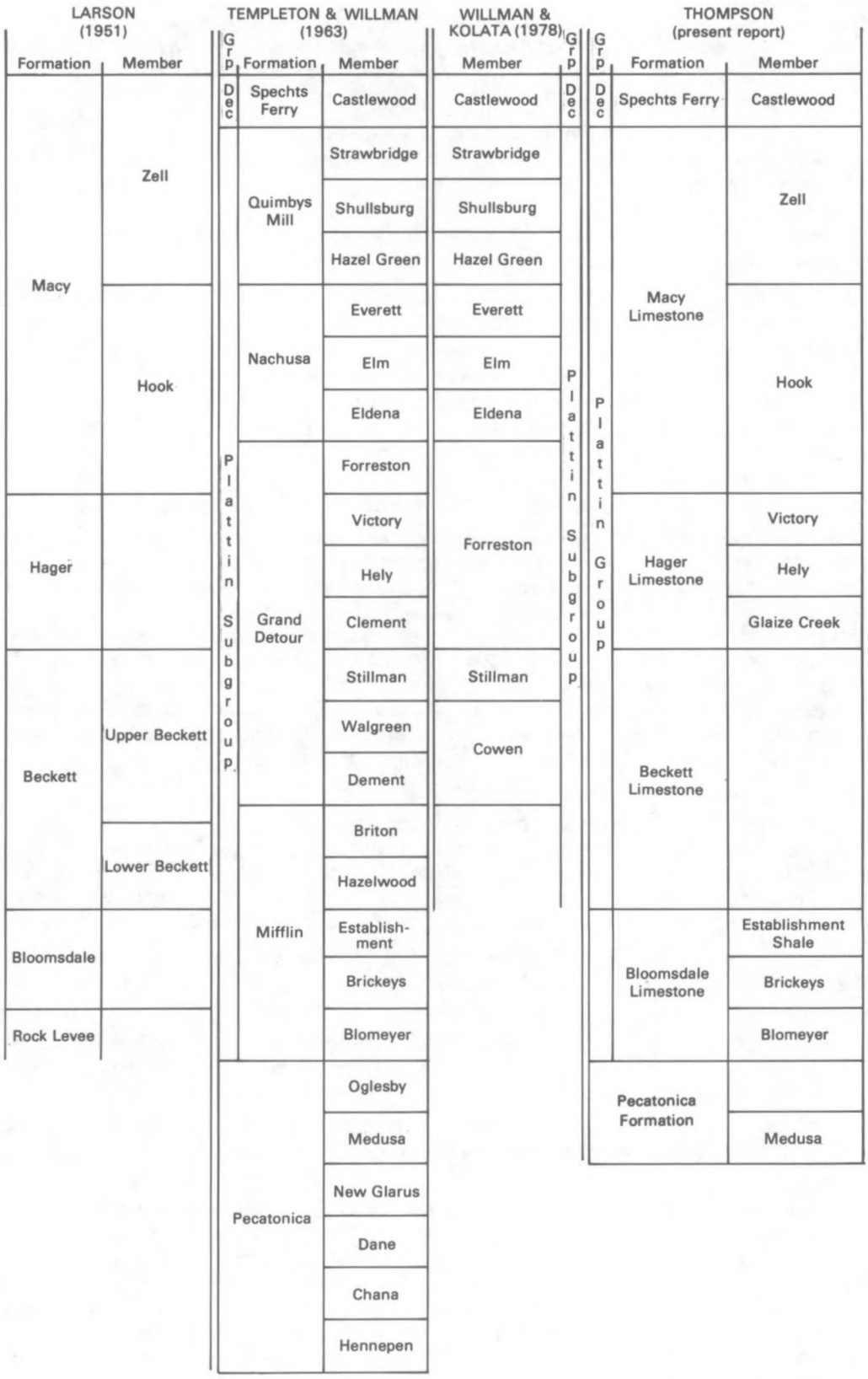


Figure 78. *Division of the* **Plattin Group** *by Larson (1951) compared to that of Templeton and Willman (1963), Willman and Kolata (1978), and the present report.* **Dec** *means Decorah Group.*

equivalence of thin units in the basal part of the Mifflin in northern Illinois with thicker, more prominent members in southwestern Illinois (Blomeyer and Brickeys Members) was suggested (T and W, 1952, 1963), but these units, if present, are also not sufficiently distinct to merit differentiation in northern Illinois. No Mifflin members are differentiated in this report."

They stated (p. 28) that in northern Illinois, the **Mifflin Formation**

"...rests with a sharp contact on the corrosion surface at the top of the Pecatonica Formation. The contact with the thicker bedded, less shaly Grand Detour above is usually marked by a 3- to 6-inch bed of dolomitic shale, which at one locality...contains a bentonite...In addition, at a number of places the upper part of the Mifflin contains a strong corrosion surface, a bed of calcarenite 3 to 5 inches thick, and a 6- to 8-inch bed of limestone nodules closely spaced in green shale."

Willman and Kolata (1978, p. 29) differentiated three members of the **Grand Detour Formation** principally on argillaceous content and bedding:

Forreston Member - thin- to medium-bedded limestone, contains red-brown shale partings (includes Clement, Hely, Victory, and Forreston Members of Templeton and Willman , 1963).

Stillman Member - thick-bedded to massive limestone, generally cherty, pure member.

Cowen Member - a medium-bedded, moderately pure limestone which is generally cherty and argillaceous to shaly at the top (Walgreen and Dement Members of Templeton and Willman, 1963).

They could generally differentiate these three members in Ogle, Lee, and La Salle counties, Illinois, but found it more difficult to the northwest, where the formation thins. They concluded (p. 29),

"Although these three (the Clement, Hely, and Victory Members) [the type section for the Victory is in Calhoun County, Illinois] have been tentatively identified in northern Illinois, they are not considered sufficiently distinctive to be identified with confidence, thus they are not used in this study. At present, they are included in the lower part of the Forreston Member.

"Two members that underlie the Stillman Member were based on exposures in northern Illinois -- the Walgreen, an upper argillaceous or shaly member, and the Dement, a lower relatively pure member (T and W, 1963). Although the boundary between them is sharply defined at some localities, in many others it is difficult to place, and the thickness variations suggest that the boundary has not been consistently drawn. Further, the Walgreen and Dement Members are poorly exposed and not correctly differentiated in the type section...Thus it has seemed desirable to combine them as the Cowen Member."

They added (p. 31) that the **Nachusa Formation**

"...is differentiated into three members, because of a persistent, well-bedded, argillaceous unit near the middle -- the Elm Member. The overlying Everett Member and the underlying Eldena Member are both massive units, but the lower part of the Eldena is slightly argillaceous and has thin argillaceous partings, which are scarce in the Everett. West of South Wayne, Wisconsin...where the Nachusa thins, the Elm Member is not recognized, and the formation is not differentiated into members..."

Four of the members named by Templeton and Willman, the **Brickeys**, **Establishment Shale**, **Hely**, and **Victory**, are useful markers within the Plattin throughout most of its outcrop in eastern Missouri (fig. 78). The formations they proposed, Mifflin, Grand Detour, Nachusa, and Quimbys Mill, however, are not. They do not appear to have unique lithologic characteristics that allow separate identification. Many of the members proposed by Templeton and Willman may be present at some localities, but are not recognizable at others. Most are not recognizable in the field in eastern Missouri.

For the Plattin succession in Missouri it is herein proposed to adopt the classification introduced by Larson (1951). McCart (1986) described the four formations as follows:

Top of Plattin Group

Macy Limestone--"...lithographic to fine-grained fucoidal limestone with scattered chert, intraformational limestone and calcarenite lenses below and grayish brown, fine-textured limestone with greenish shale partings above..." (**Hook** and **Zell Members**)

Hager Limestone--"...a mixture of light gray, gray to dark brown thinly bedded lithographic to fine-grained limestone with interbedded calcarenite, thin shaly dolomitic partings, capped by a white to light gray lithographic limestone..." (**Victory**, **Hely**, and **Clement Members** of Templeton and Willman).

Beckett Limestone--"...yellowish brown, lithographic to fine-grained fucoidal limestone with layers of intraformational limestone, calcarenite and scattered chert in the upper part..."

Bloomsdale Limestone--"...light brown lithographic to fine-grained limestone and buff dolostone with green shale layers..." (**Brickeys** and **Establishment Shale Members** over most of eastern Missouri; and **Blomeyer Member** in Cape Girardeau and Scott Counties).

In the region of outcrop of Plattin rocks in Missouri (fig. 76), four formations of the **Plattin Group** can be identifed everywhere except in the northeastern counties north of St. Charles County, where the Hager Limestone is absent. If the Hager Limestone cannot be identified (or is absent), the close similarity of the Macy and Beckett Limestones renders their separation essentially impossible.

Two members named by Larson and five by Templeton and Willman are included within the four formations; one new member (**Glaize Creek Member**) is proposed. The following is the proposed classification:

Plattin Group
- Macy Limestone
  - Zell Member
  - Hook Member
- Hager Limestone
  - Victory Member
  - Hely Member
  - Glaize Creek Member
- Beckett Limestone
- Bloomsdale Limestone
  - Establishment Shale Member
  - Brickeys Member
  - Blomeyer Member (extreme southeastern Missouri only)

In Ste. Genevieve County, Larson (1951) divided the Macy Limestone into two members, the **Hook Member** and overlying **Zell Member**. The writer has recognized these facies in many of the eastern and southeastern Missouri exposures and considers them to be valid members of the Macy Limestone. They will be discussed in more detail under **Macy Limestone.**

In a few sections the Hager Limestone appears to be represented only by the Victory Member. If the Glaize Creek Member is absent, the Hely Member cannot be distinguished from the upper beds of the underlying Beckett Limestone. The Glaize Creek Member, usually composed of calcareous mudstone and thin grainstone beds, occurs at a few sections only as a grainstone; the **"Clement grainstone facies"** of the Glaize Creek.

To summarize the Plattin Group in Missouri, the basal beds are a distinctive chocolate-brown mudstone to oolitic grainstone interbedded with tan laminated "birdseye" dolomite. This, the **Brickeys Member**, and the overlying green shale and interbedded limestone of the **Establishment Shale Member,** form the distinctive basal part of the Plattin Group, the **Bloomsdale Limestone**, which is easily distinguished from the underlying formations (Joachim Dolomite or "Pecatonica Formation") and from the overlying Beckett Limestone, which represents the "typical Plattin," a burrowed ("fucoidal") mudstone. The "typical Plattin" comprises the **Beckett**, **Hager**, and **Macy Limestones**. In much of east-central Missouri, beneath the Victory, is a similar-appearing calcarenous mudstone and grainstone, separated from the Victory by less than one to several feet of more "typical" burrowed nodular bedded mudstone. Where these three lithologic units are present, three members can be identified, the **Glaize Creek**, **Hely**, and **Victory**, which constitute the **Hager Limestone**. Although only the Victory Member is present at some localities, identification of the Hager may be advantageous to some studies of the Plattin, because it indicates a divergence from the normal transgressive nature of the Plattin, to a regressive phase (McCart, 1986), and can serve as an excellent marker for detailed mapping.

At sections in northeastern Missouri where the Victory Member is absent, the sequence is best called the **Plattin Limestone**. Lower Bloomsdale strata are rarely exposed, and only post-Bloomsdale limestones are generally encountered. Division into formations is not easily made. The Establishment Shale and Brickeys Members, where found, are treated as members of the **Plattin Limestone**. The Plattin is less than 90 ft thick in northeastern Missouri, 90-400 ft in east-central and southeastern Missouri (fig. 76).

The Plattin sequence of eastern Missouri was deposited in a tidal flat, lagoon, and shallow-sea complex that covered much of central North America during Mohawkian time. McCart (1986) defined the depositional environment of the Hager Limestone as **supratidal** and that of the underlying and overlying limestones (Beckett and Macy Limestones) as **subtidal** to **intertidal**. The immediate pre-Hager limestone of the Beckett is of intertidal origin, and the grainstone ("Clement grainstone facies") of the Glaize Creek

Member represents a transition from intertidal to subtidal conditions. McCart (p. 48) stated,

> "This transition is shown by the change from the fucoidal biomicrites of the Stillman Member to the calcarenitic pelsparites, biosparites and more fragmented biomicrites of the Clement. In areas of higher elevation or in a more protected setting, the Clement Member may not be deposited and the Hely lithologies may have been deposited instead."

Overall, the Plattin Group represents a transgressive sequence over a shallow shelf. However, McCart, (p. 53) stated,

> "The Hager Formation...is a regressive, carbonate, tidal sequence formed in a humid setting. It is the only representative of such a setting in the Plattin. The Beckett and Macy formations are subtidal in nature and are part of the overall transgression of the Plattin epeiric seas in the Mid-continent."

Bloomsdale Limestone

Larson, 1951

Original description -- (Larson, 1951, p. 2046) "The name Bloomsdale is applied to a formation characterized by calcilutite and fine-textured dolomite rock with interbeds of oolite and carbonate-pebble conglomerate contrasting to the overlying fucoidal Beckett limestone. Green shale is common in the upper beds in the central and northern areas of outcrop."

Type section -- Larson (1951, p. 2046) stated, "The name is from the town of Bloomsdale in Sec. 14 (proj.), T. 38 N., R. 7 E., Ste. Genevieve County. The type section, 3½ miles east in the bed of a small stream rising in the SW.¼, NE.¼, Sec. 15, T. 38 N., R. 8 E., near an abandoned stone house, has 61 feet of beds between the Rock Levee and the succeeding Beckett formation." This section is in the Bloomsdale 7½' Quadrangle (figs. 79 and 80).

Reference sections -- The type section of the Bloomsdale is not easily accessible. A complete section is exposed in a quarry 1.75 mi south of the type section, E½ NW¼ NE¼ sec. 28, T. 38 N., R. 8 E., Weingarten 7½' Quadrangle (fig. 81A).

Excellent exposures of the Bloomsdale Limestone are in roadcuts on U.S. Highway 30, 1.5 mi northeast of Cedar Hill (figs. 71 and 82), center S½ NW¼ sec. 18, T. 42 N., R. 4 E., and near Weber Hill, NE¼ sec. 27, T. 43 N., R. 4 E., (fig. 68), Jefferson County, Missouri.

The Bloomsdale Limestone is also exposed in a roadcut on I-55, 0.5 mi north of the bridge over Joachim Creek, at mile post 180, in Jefferson County (figs. 69 and 70A), and in a roadcut on a side road to St. Charles

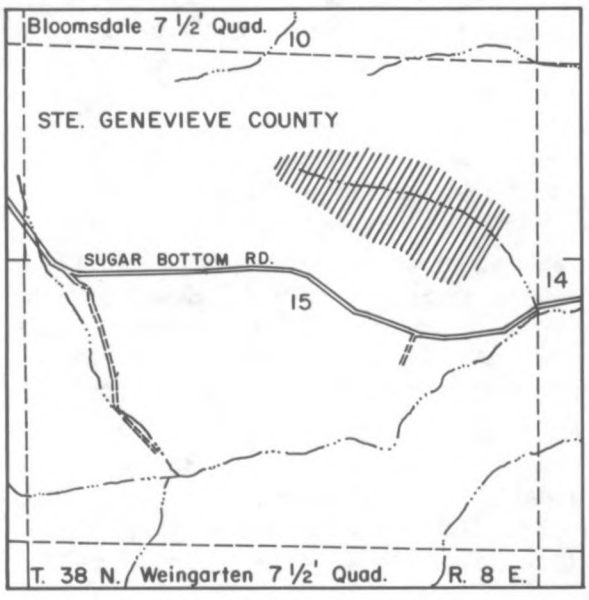
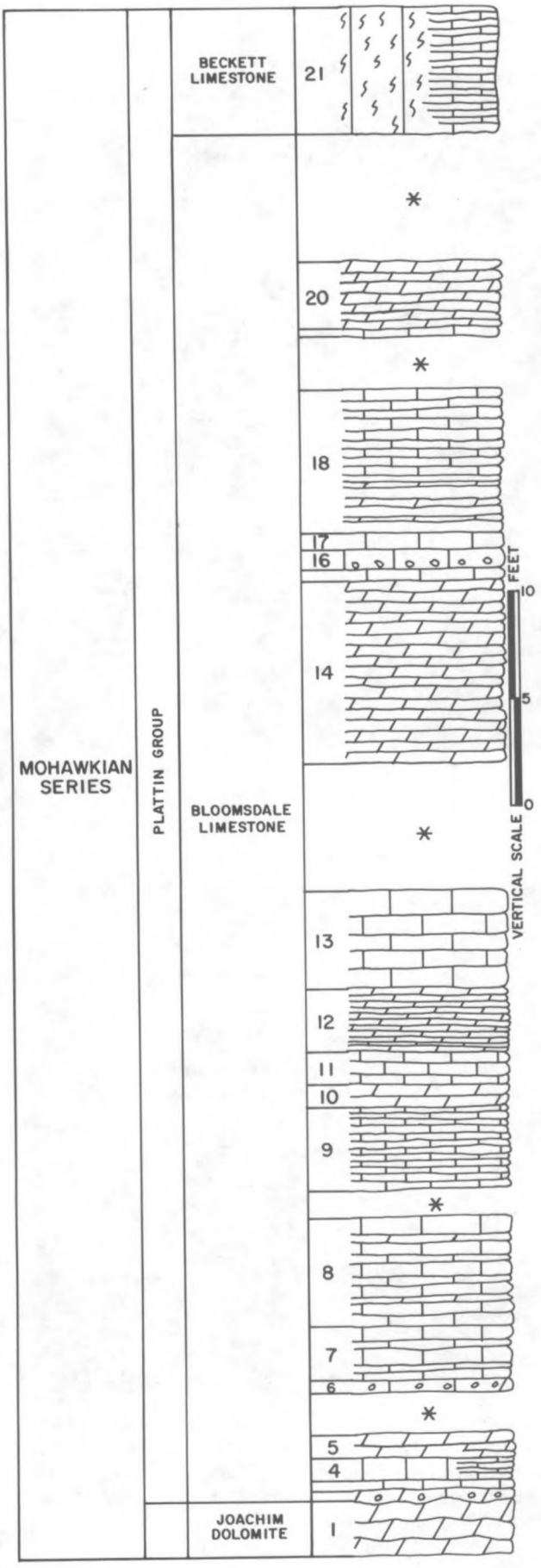


Figure 79. *Parts of the Bloomsdale and Weingarten 7½' quadrangles showing the location of the type section of the* **Bloomsdale Limestone.**



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
PLATTIN GROUP
Beckett Limestone
21. Limestone, medium brownish-gray, finely crystalline, burrowed.

Bloomsdale Limestone (64.6 ft)
Covered interval (6 ft)
Brickeys Member
20. Dolomite, buff. (3 ft)
19. Limestone, brown, sublithographic. (0.3 ft)
Covered interval (2.4 ft)
18. Limestone, light-brown; vertical calcite-filled tubes and *Cryptozoon*; interbedded thin dolomite in lower part. (6.6 ft)
17. Limestone, pinkish gray. (0.8 ft)
16. Limestone, brown, oolitic. (1 ft)
15. Limestone, brown. (0.7 ft)
14. Dolomite, buff; in 0.5-0.6-ft beds with calcite geodes. (8.9 ft)
Covered interval (6 ft)
13. Limestone, light-brownish-gray; in 1-ft beds. (4.4 ft)
12. Dolomite, brownish-gray, platy. (3 ft)
11. Limestone, light-brownish-gray. (1.6 ft)
10. Dolomite, grayish-yellow. (1 ft)
9. Limestone, light-brown; contains *Eoliperditia*; in 0.2 ft beds. (4 ft)
Covered interval (1.5 ft)
8. Limestone, brown, dolomitic; scattered calcarenite grains. (5 ft)
7. Limestone, light-brown; interbedded calcarenite. (2.5 ft)
6. Limestone, brown, dolomitic; scattered oolites. (0.7 ft)
Covered interval (2 ft)
5. Dolomite, yellowish-gray. (1.2 ft)
4. Dolomite, brownish-gray, finely crystalline; in 0.1 ft beds. (1 ft)
3. Limestone, brown; contains *Eoleperditia*. (0.5 ft)
2. Dolomite, buff, oolitic; interbedded brown limestone. (0.5 ft)

Joachim Dolomite
1. Dolomite, buff; irregular, massive beds.

Figure 80. *Type section of the* **Bloomsdale Limestone**, *SW¼ NE¼ sec. 15, T. 38 N., R. 8 E., Ste. Genevieve County, Bloomsdale 7½' Quadrangle. Adapted from a description by Larson (1951).*

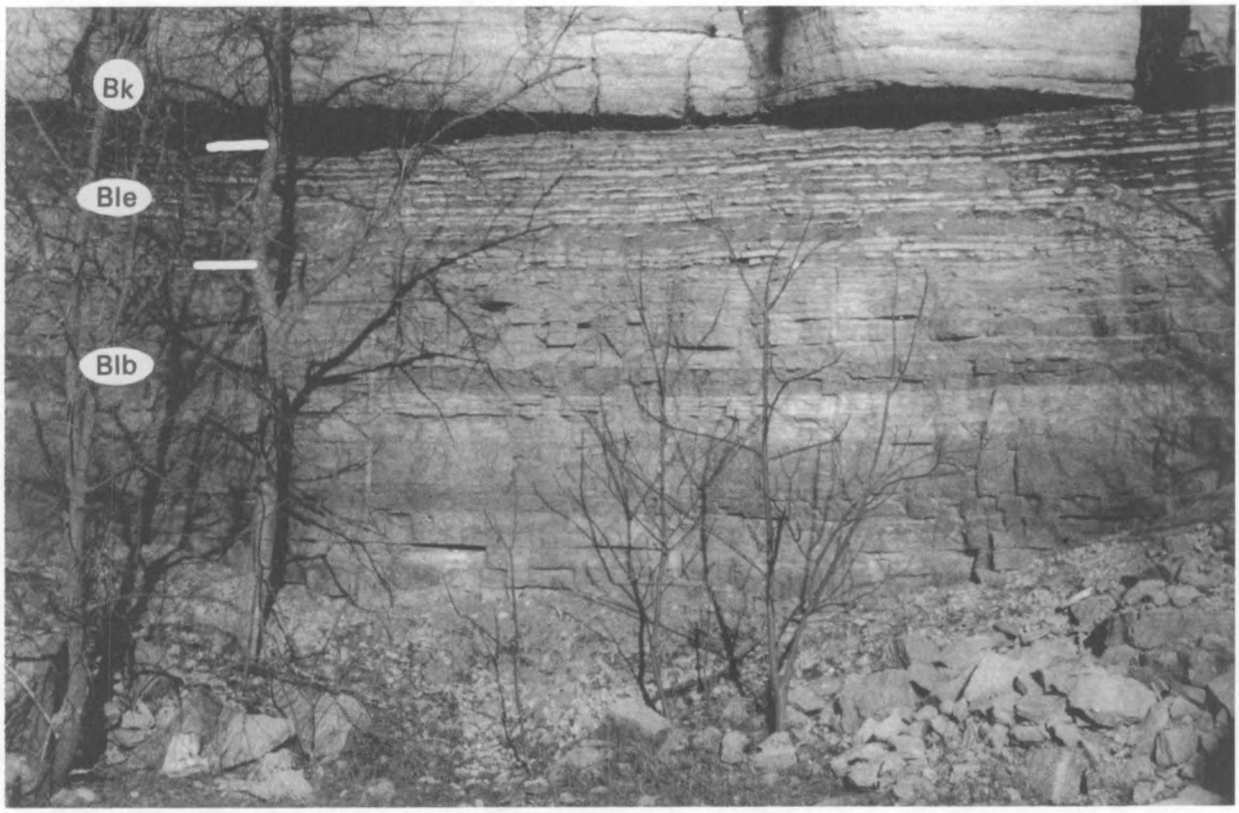


Figure 81 (A) ▲

Figure 81 (B) ▼

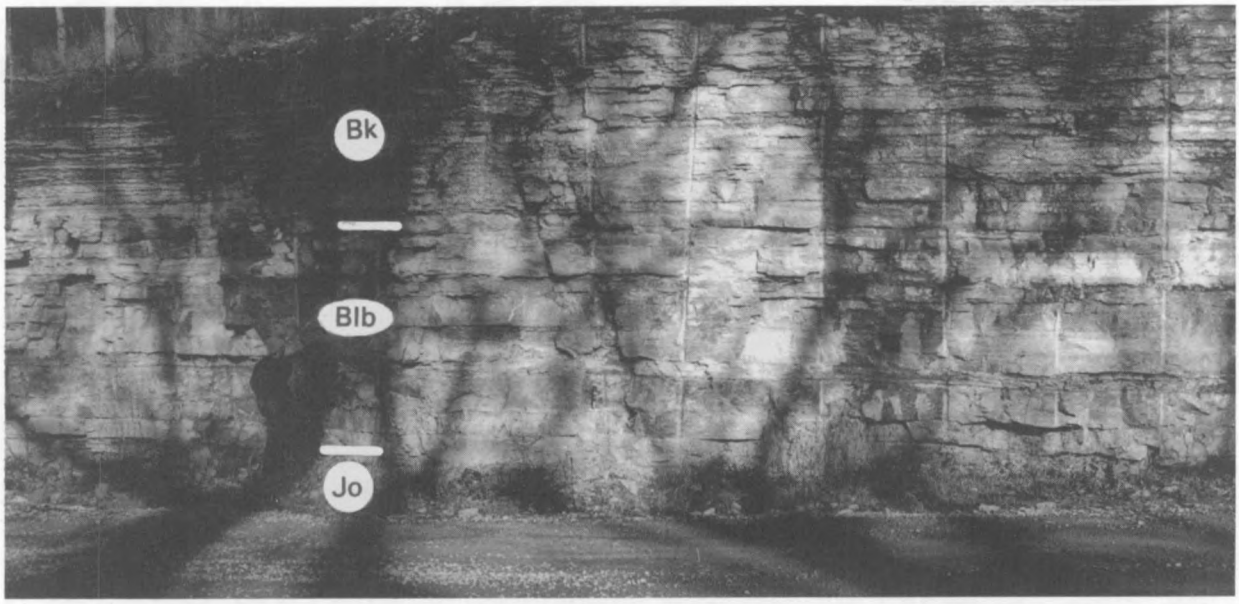


Figure 81. **Bloomsdale Limestone**. **(A)** *Quarry 1.75 mi south of the type section (1.25 mi north of type section of the* **Establishment Shale Member***), E½ NW¼ NE¼ sec. 28, T. 38 N., R. 8 E., Ste. Genevieve County, southeastern Missouri, Weingarten 7½' Quadrangle (fig. 86).* **(B)** *Roadcut on a side road to St. Charles County Highway F, 1.5 mi west of Defiance (fig. 74), Labadie 7½' Quadrangle; only the* **Brickeys Member** *is present.* **(Blb)** *Brickeys Member of Bloomsdale Limestone;* **(Ble)** *Establishment Shale Member of Bloomsdale Limestone;* **(Bk)** *Beckett Limestone;* **(Jo)** *Joachim Dolomite. Photographs by T.L. Thompson.*

County road F, northwest of Defiance, SW¼ NE¼ SE¼ sec. 21, T. 45 N., R. 2 E. (figs. 74 and 81B). At the latter section, the Establishment Shale Member appears to be absent.

History of nomenclature

1951	**Larson**	**Bloomsdale formation**
1954	Twenhofel et al.	Bloomsdale limestone
1961	Martin et al. (a)	Plattin formation (lower part)
1963	Templeton and Willman	Mifflin Formation (lower part) Establishment Member Brickeys Member Blomeyer Member
1977	Thacker and Satterfield	Plattin Formation (lower part) Establishment Shale
1978	Willman and Kolata	Mifflin Formation (lower part)
1982	Thompson	Plattin Limestone (lower part)
1986	McCart	Bloomsdale Formation
1991	**Thompson (present report)**	**Bloomsdale Limestone** **Establishment Shale Member** **Brickeys Member** **Blomeyer Member** (southeastern Missouri only) **Plattin Limestone** (lower part; northeastern Missouri) **Establishment Shale Member** **Brickeys Member**

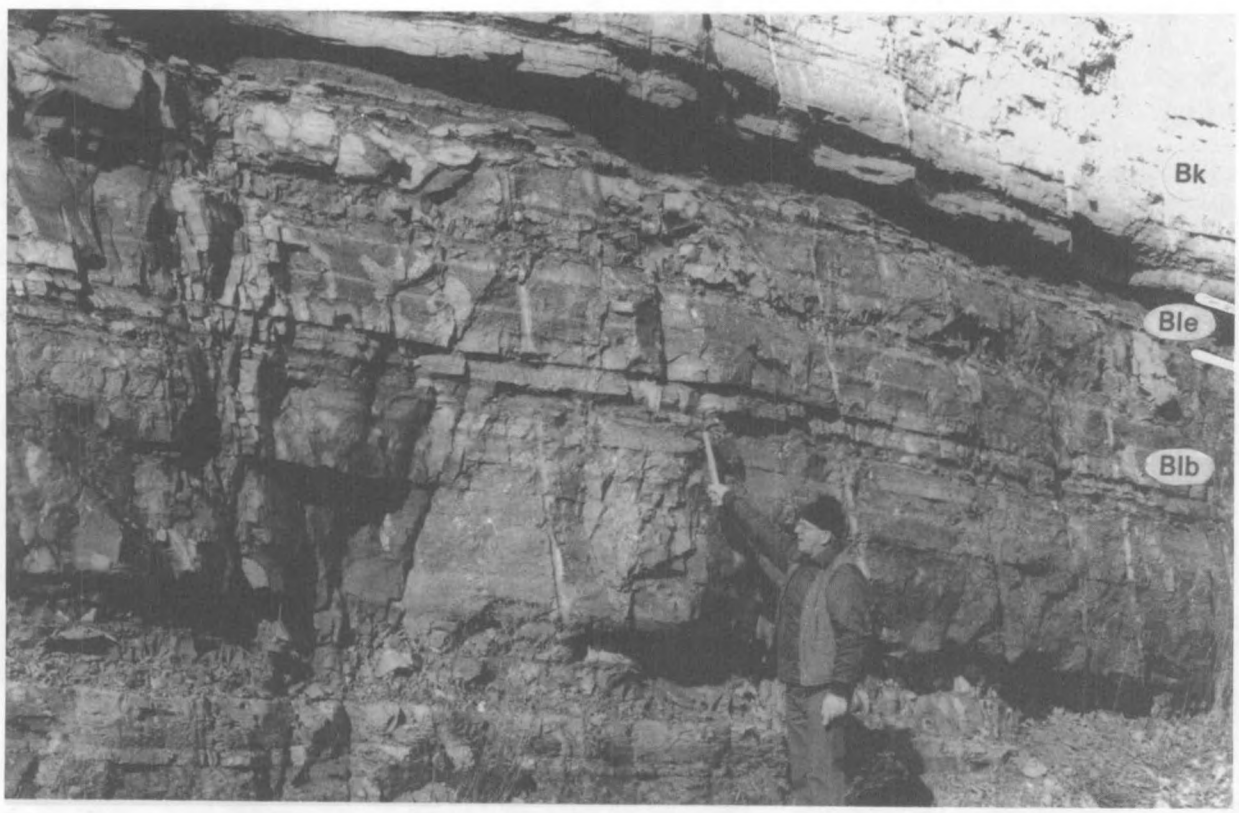


Figure 82. **Bloomsdale Limestone** *in a roadcut on Missouri Highway 30, 1.5 mi north of Cedar Hill, center S½ NW¼ sec 18, T. 42 N., R. 4 E., Jefferson County, Missouri, House Springs 7½' Quadrangle (figs. 70B and 71).* (**Blb**) *Brickeys Member of Bloomsdale Limestone;* (**Ble**) *Establishment Shale Member of Bloomsdale Limestone;* (**Bk**) *Beckett Limestone. Photograph by T.L. Thompson.*

Remarks -- The Bloomsdale Limestone includes the basal beds of the Plattin Group, from the top of the underlying formation (Joachim Dolomite in most of Missouri; "Pecatonica Formation" in extreme southeastern Missouri, Perry, Cape Girardeau, and Scott counties) up to the top of the Establishment Shale Member. Limestones (**Brickeys Member**) are generally brown to chocolate brown mudstone to oolitic grainstone, interbedded with brown dolomite and dolomitic shale. The **Establishment Shale Member** is a green shale with interbedded thin brown limestones. The contact with the underlying Joachim Dolomite is undulating (figs. 70A and 81B) and is considered by most to be disconformable. The Bloomsdale is quite different from the rest of the overlying Plattin and can be readily distinguished from the light gray burrowed mudstones above.

In southern Perry, Cape Girardeau, and northern Scott counties, a third member, the **Blomeyer Member**, underlies the Brickeys and lies on the "Pecatonica Formation." Quarrying destroyed the type section; currently, the best exposure is in the Southeast Stone Company quarry (where the type section was located), southwest of Cape Girardeau. The massive limestone of the "upper Pecatonica" underlies the limestone and dolomite beds of the Blomeyer Member.

Blomeyer Member of Bloomsdale Limestone

Templeton and Willman, 1963; Thompson, 1991 (present report)

Original description -- (Templeton and Willman, 1963, p. 81) "The unit is limestone or dolomite, argillaceous, lithographic to chalky, blue-gray to brown-gray, and weathers gray to buff. It commonly weathers thin bedded to shaly. In the southern outcrop area it locally contains a few beds of calcareous shale as much as 6 inches thick. It is generally recognized as the basal shaly or impure unit of the Mifflin."

Type section -- Templeton and Willman (1963, p. 80) stated, "The Blomeyer Member...is here named for the village of Blomeyer, Missouri, about 6 miles southwest of the type section, which is a small quarry on the north side of Missouri Highway 74, a quarter of a mile east of the highway junction at Rock Levee, Cape Girardeau County." This quarry was in the SE¼ SW¼ sec. 13, T. 30 N., R. 13 E., approximately 0.5 mi east of the junction of Missouri Highway 74 and I-55, Cape Girardeau 7½' Quadrangle. It was destroyed as the 400-ft-deep Southeast Stone Company quarry (fig. 64) was developed; Blomeyer, Brickeys, and Establishment Members are now exposed in the uppermost (eastern) part of this quarry, and are also exposed in the bottom of the 400-ft-deep Lonestar Cement Company quarry, about 1.5 mi to the northeast.

Templeton and Willman (1963, p. 231) described the type section of the Blomeyer as follows:

Brickeys Limestone Member (9 ft 2 in.)	
Limestone, brown, lithographic to fine grained; weathers thin bedded and slightly shaly	4' 4"
Limestone, as above but in thin to medium beds; locally shaly; poorly exposed	4'
Limestone, brown, lithographic, massive, laminated, oolitic	10"
Limestone and shale; makes reentrant	3"
Limestone, brown, thin to medium beds, shaly; thick shale partings in lower 11"	2' 2"
Shale, brown with lenses of limestone; makes reentrant	2"
Limestone, very shale	9"
Blomeyer Limestone Member (12 ft 1 in.)	
Limestone, brown, lithographic, massive	2' 6"
Limestone, gray, weathering white, lithographic, massive	1' 2"
Limestone, brown, lithographic, massive	3'10"
Shale, calcareous, red-brown	1"
Limestone, brown, lithographic, thin to medium bedded	1' 2"
Pecatonica Formation	

Remarks -- In southern Cape Girardeau County, the **Blomeyer Member** of the Bloomsdale Limestone has been identified between the Brickeys and the underlying "Pecatonica Formation," but is known only from a few exposures near the area of the type section. The best exposure is in the Southeast Stone Company quarry, at the location of the former type section.

The Blomeyer Member has been identified as far north as the type section of the Brickeys Member, in northern Ste. Genevieve County, but is not easily separated from the Brickeys. In most sections it is probably not recognizable and would be considered part of the Brickeys Member.

Brickeys Member of Bloomsdale Limestone
Templeton and Willman, 1963; Thompson, 1991 (present report)

Original description -- (Templeton and Willman, 1963, p. 81) "In the southern area the Brickeys consists mostly of pure, purplish brown, lithographic to fine-grained, thick-bedded limestone, but it contains a few beds of gray to buff, argillaceous, thin-bedded limestone and dolomite and several thin beds of green shale. Several of the limestone beds are oolitic, others a fine conglomerate or breccia. The member is characterized by several prominent scour surfaces which commonly have a relief of 2 to 4 inches but locally of as much as 8 inches. Scour surfaces 2 and 8 feet below the top and at the base are the most persistent. A thin bentonite is found 2 feet 4 inches above the base in the section at Zell."

Type section -- Templeton and Willman (1963, p. 81) stated, "The Brickeys Member...is here named for the village of Brickeys, in Ste. Genevieve County, southeastern Missouri. The type section is an exposure in a quarry on the east side of Missouri 25, 0.3 mile south of the side road to Brickeys." This little quarry (their Kinsey Creek Section, p. 231), on U.S. Highway 61 (formerly Highway 25), is in the SE¼ SW¼ SE¼ sec. 28, T. 39 N., R. 7 E., Danby 7½' Quadrangle (figs. 83-85). The quarry is in the Brickeys and Establishment Shale Members of the Bloomsdale Limestone, and the lower few feet of the overlying Beckett Limestone. As shown in the photograph (fig. 85), the quarry is not a single face, but a series of low benches a few feet high, the highest face containing the Establishment Shale Member and Beckett Limestone.

Reference sections -- There are several excellent exposures of the Brickeys Member of the Bloomsdale Limestone in roadcuts. Roadcuts on Missouri Highway 30, about 1 mi north of Cedar Hill, center S½

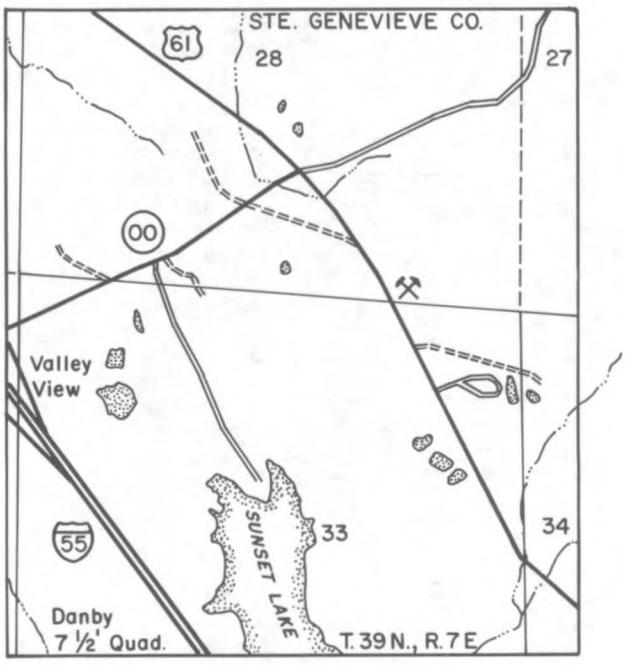
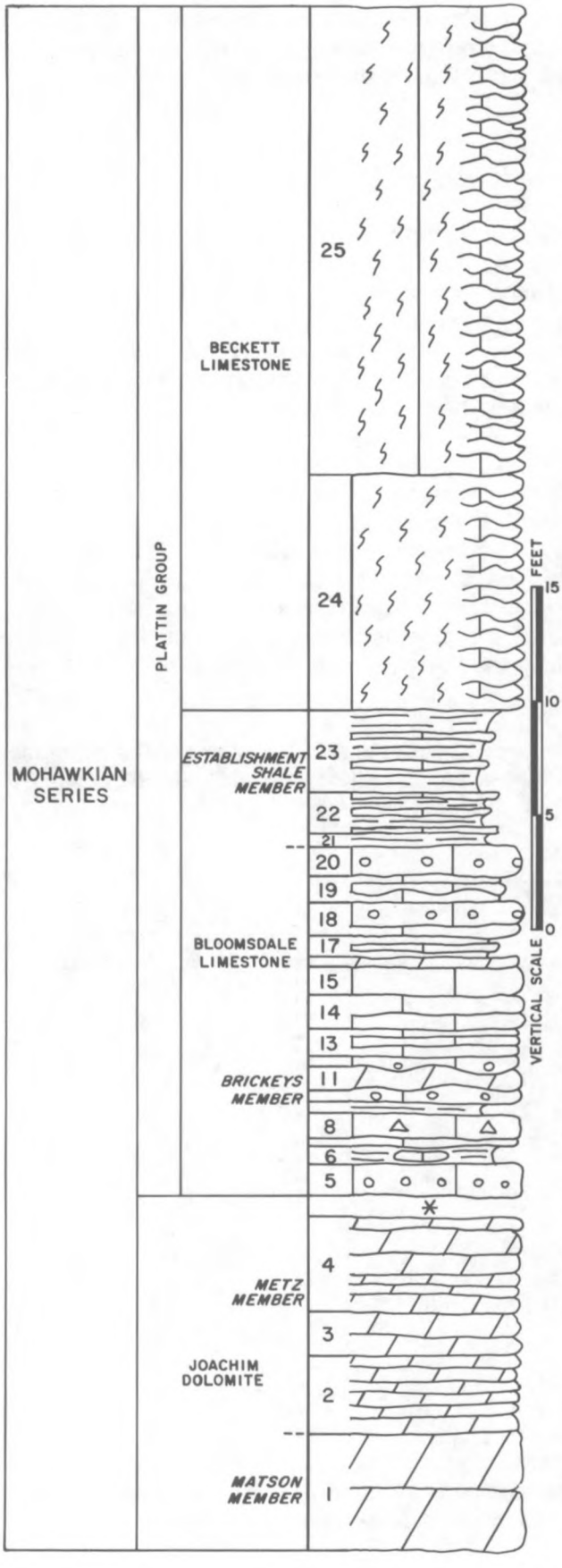


Figure 83. *Part of the Danby 7½' Quadrangle, showing the location of the type section of the* **Brickeys Member of the Bloomsdale Limestone**, *a small quarry on U.S. Highway 61 in Ste. Genevieve County, SE¼ SW¼ SE¼ sec. 28, T. 39 N., R. 7 E., southeastern Missouri.*



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
PLATTIN GROUP
Beckett Limestone (62 ft)

25. Limestone, brown, lithographic, dolomite-mottled; thin to medium irregular beds; contains layers of crinoidal calcarenite. (51 ft)
24. Limestone, gray, lithographic, dolomite-mottled, thick bedded; locally finely fucoidal. (10 ft 2 in.)

Bloomsdale Limestone (20 ft)
Establishment Shale Member (5 ft)

23. Shale, green. (3 ft)
22. Limestone, argillaceous, calcarenitic; interbedded with thin green shale. (1 ft 9 in.)
21. Shale, green. (4 in.)

Brickeys Member (15 ft)

20. Limestone, gray, mainly pure, very finely crystalline, laminated, massive; contains a few argillaceous streaks; locally oolitic and conglomeratic. (1 ft 4 in.)
19. Limestone, lithographic, conglomeratic, oolitic; locally dolomitic in lower half; scour surface at base; 5-in. green shale at top, 2-4-in. green shale at base. (1 ft - 1 ft 4 in.)
18. Limestone, gray, pure, lithographic; oolitic, finely conglomeratic middle 10 in.; shale parting 7 in. above base. (1 ft 9 in.)
17. Shale and interbedded limestone; shale, green to dark-gray; limestone, gray, argillaceous, faint dark mottling, thin-bedded to massive. (9 in.)
16. Dolomite, argillaceous, blue-gray. (3 in.)
15. Limestone, light-brownish-gray, white weathering, lithographic, laminated; calcite flecks. (1 ft 3 in.)
14. Limestone, oolitic, brown, lithographic; shale parting 7 in. above base. (1 ft 5 in.)
13. Limestone, dolomitic, gray, mottled brown, thin-bedded; mud-cracked surfaces; floor of upper bench in quarry. (1 ft 5 in.)
12. Limestone, brown, lithographic, oolitic, massive; scour surface at base. (0-12 in.)
11. Dolomite, silty; algal domes. (0-5 in)
10. Limestone, dolomitic, argillaceous, laminated; partly conglomeratic and oolitic; contains algal structures. (6-13 in.)
9. Shale, dark-gray. (3 in.)
8. Limestone, gray, white weathering, pure, lithographic, laminated; calcite flecks; conglomeratic at top. (1 ft 3 in.)
7. Limestone, gray, argillaceous, thin-bedded, mud-cracked; green shale partings. (4 in.)
6. Shale, gray-green; lenses of argillaceous limestone. (8 in.)
5. Limestone, brown, white weathering, lithographic, massive, partly oolitic; *Stromatocerium* at top; base at floor of quarry (may be northern remnant of Blomeyer Member). (1 ft 7 in.)

Covered interval. (8 in.)

Joachim Dolomite (15 ft)
Metz Member (9 ft 10 in.)

4. Dolomite, silty, thin- to medium-bedded, shaly to massive; basal 9 in. pure, vuggy, massive. (4 ft 8 in.)
3. Dolomite, gray with dark gray streaks, silty, medium-bedded. (1 ft 6 in.)
2. Dolomite, same, thin-bedded, shaly. (3 ft 10 in.)

Matson Member (5 ft)

1. Dolomite, buff, finely vuggy, laminated, thick-bedded; base concealed (in road ditch). (5 ft.)

Figure 84. *Type section of the* **Brickeys Member of the Bloomsdale Limestone**, *Ste. Genevieve County, southeastern Missouri (fig. 83). Adapted from a description by Templeton and Willman (1963, p. 231).*

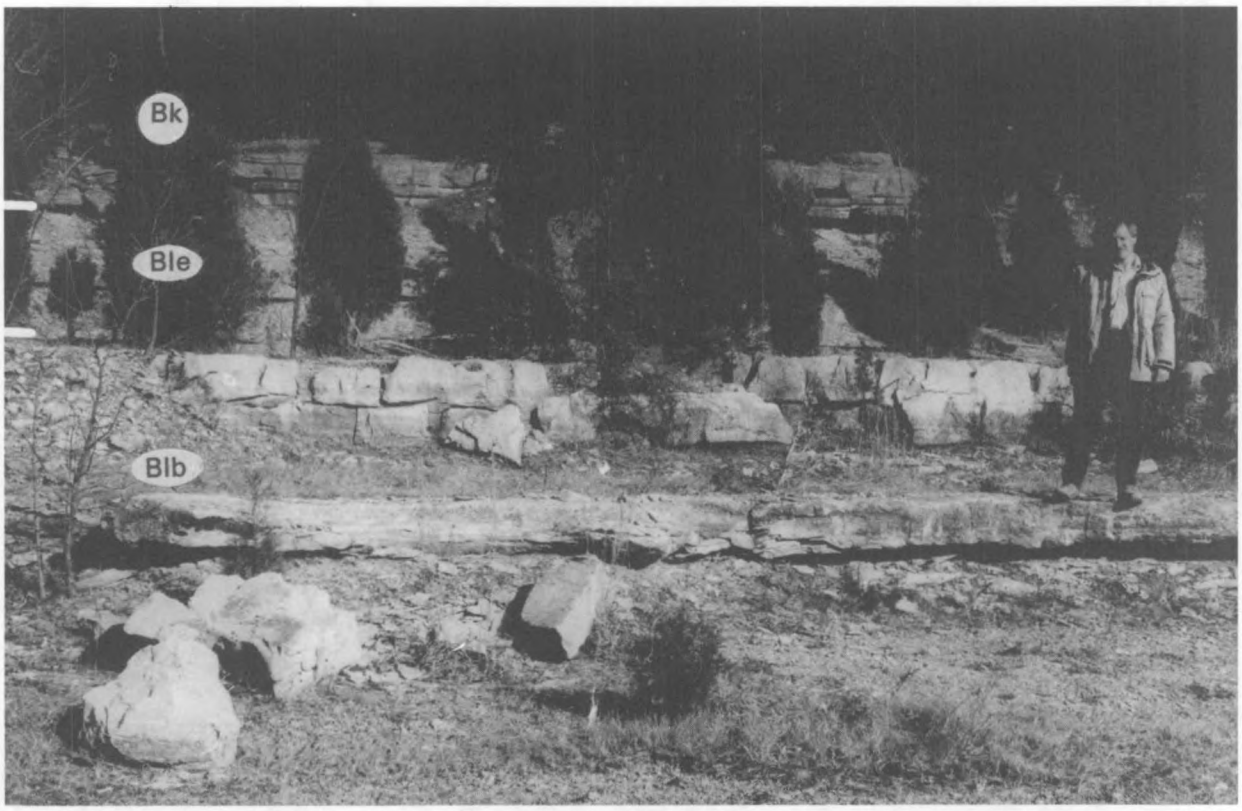


Figure 85. *Type section of the* **Brickeys Member of the Bloomsdale Limestone** *(fig. 84).* **(Blb)** *Brickeys Member of Bloomsdale Limestone;* **(Ble)** *Establishment Shale Member of Bloomsdale Limestone;* **(Bk)** *Beckett Limestone. Photograph by T.L. Thompson.*

NW¼ sec. 18, T. 42 N., R. 4 E. (figs. 70B, 71, and 82), and near the town of Weber Hill, NE¼ sec. 27, T. 43 N., R. 4 E. (fig. 68), Jefferson County, House Springs 7½' Quadrangle, exhibit the characteristics of the member. Another is in a roadcut at mile post 180 on I-55, approximately 0.5 mi north of the bridge over Joachim Creek in east-central Jefferson County, east-central Missouri, W½ NW¼ sec. 19, T. 41 N., R. 6 E., Herculaneum 7½' Quadrangle (figs. 69 and 70A).

In a roadcut on a side road to St. Charles County road F, 1.75 mi northwest of Defiance, SW¼ NE¼ SE¼ sec. 21, T. 45 N., R. 2 E. (figs. 74 and 81B), the Establishment Shale Member of the Bloomsdale Limestone appears to be absent; the Bloomsdale is composed entirely of the Brickeys Member. At this section some of the limestone beds of the Brickeys are distinctly cross-laminated grainstones.

History of nomenclature

1951	Larson	Bloomsdale formation (lower part)
1961	Martin et al. (a)	Plattin formation (lower part)
1963	**Templeton and Willman**	**Brickeys Member of Mifflin Formation**
1967	Farrell	Brickeys Member of Mifflin Formation
1978	Willman and Kolata	Mifflin Formation (lower part)
1991	**Thompson (present report)**	**Brickeys Member of Bloomsdale Limestone**
		Brickeys Member of Plattin Limestone

Remarks -- In Missouri the Brickeys Member of the Bloomsdale Limestone is present throughout the known occurrence of the formation. The base of the Plattin is marked throughout the subsurface by oolitic limestone of the Brickeys. According to Templeton and Willman (1963), the Brickeys is markedly uniform in lateral continuity, individual beds being traceable over nearly its entire outcrop area from Calhoun County, Illinois, to Cape Girardeau County, Missouri. In southern Perry, Cape Girardeau, and Scott

counties the Brickeys is a purer limestone than the underlying **Blomeyer Member**, which is more shaly; regionally, however, the Blomeyer may be considered part of the Brickeys. The overlying Establishment Shale Member is a prominent marker unit in eastern and southeastern Missouri, but appears to be very thin or absent in some sections in St. Charles (figs. 74 and 81B), St. Louis (fig. 61), and Jefferson counties.

Because the brown, massive, wavy-bedded, often oolitic limestone of the Brickeys Member is readily distinguished from the gray, burrowed limestone of the "typical Plattin" above the Establishment Shale Member, Larson (1951) identified the interval including the Brickeys and Establishment Shale as the "Bloomsdale Formation" (fig. 78), the basal formation of the Plattin Group. Identifying the Brickeys oolite is vital to recognizing basal Plattin in the subsurface of Missouri.

The chocolate brown, oolitic, conglomeratic, calcareous mudstone and fine grainstone of the Brickeys Member can be recognized from northern Scott County to Pike County, southeastern to northeastern Missouri. Limestone beds are separated by prominent shale beds in the type region of the Brickeys Member, but the shale decreases northward and southward from the type area. Limestone beds are separated by light-brown, laminated, "birdseye" dolomite in east-central Missouri. The Brickeys varies from less than 10 ft thick (figs. 74 and 81B) in St. Charles County, to 40 ft in Cape Girardeau County.

Establishment Shale Member of Bloomsdale Limestone

Templeton and Willman, 1963; Thompson, 1991 (present report)

Original description -- (Templeton and Willman, 1963, p. 82) "In the southern outcrop area the Establishment Member consists of blue-green, laminated clay or shale with thin interbeds of argillaceous, greenish gray to buff, chalky limestone...The shale facies appears to be limited to the region bordering the Ozarks where it is an excellent key bed. From that area it grades into shaly limestone. In the northern outcrop area the limestone is dolomite mottled, argillaceous, blue-gray to buff, lithographic, thin bedded, and shaly, it contains some calcarenite or coquina layers, and it grades into fine-grained dolomite at places."

Type section -- Templeton and Willman (1963, p. 82) stated, "The Establishment Member of the Mifflin Formation is here named for Establishment Creek in Ste. Genevieve County, southeastern Missouri. The type section is an exposure in a ravine just north of the village of Zell." This section (figs. 86-88) is in the W½ sec. 34, T. 38 N., R. 8 E., Weingarten 7½' Quadrangle; it was described by Templeton and Willman (1963, p. 231-232). At its type section the Establishment Shale Member is exposed under a small waterfall in a hog pen (fig. 88); at the time the present report was written (1986-87), the section was not accessible, as the hogs were rather large.

Reference sections -- The Establishment Shale Member of the Bloomsdale Limestone is well exposed in a quarry 1.25 mi north of the type section, in E½ NW¼ NE¼ sec. 28, T. 38 N., R. 8 E., Weingarten 7½' Quadrangle (fig. 81A).

Two other excellent exposures of the Establishment Shale Member are (1) a roadcut on I-55 at mile post 180, 0.5 mi north of the bridge over Joachim Creek (figs. 69 and 70A), described previously under **Plattin Limestone**, W½ NW¼ sec. 19, T. 41 N., R. 6 E., eastern Jefferson County, Missouri, Herculaneum 7½' Quadrangle, and (2) roadcuts on Missouri Highway 30, north of Cedar Hill and near Weber Hill, Jefferson County (figs. 68, 71, 82, and 89A).

At the Lewis Road interchange to I-44, center W½ SW¼ sec. 33, T. 44 N., R. 4 E., St. Louis County, Missouri (figs. 61 and 89B), the Establishment Shale Member is very thin. In a roadcut on a side road to St. Charles County road F, near Defiance, the member is entirely absent (figs. 74 and 81B).

History of nomenclature

1951	Larson	Bloomsdale formation (upper part)
1961	Martin et al. (a)	Plattin formation (part)
1963	**Templeton and Willman**	**Establishment Member of Mifflin Formation**
1977	Thacker and Satterfield	Establishment shale of Plattin Formation

1978	Willman and Kolata	Mifflin Formation (middle part)
1991	**Thompson (present report)**	**Establishment Shale Member of Bloomsdale Limestone**
		Establishment Shale Member of Plattin Limestone

Remarks -- The Establishment Shale Member of the Bloomsdale Limestone is an excellent marker bed for the Plattin Group in southeastern and eastern Missouri. It forms a prominent reentrant in outcrops, is widespread, and is recognized as far north as southeastern Minnesota (Templeton and Willman, 1963). Thickest in the type area, the Establishment thins northward and southward. It is over 5 ft thick at the type section, about 3 ft thick in east-central Jefferson County (fig. 69) and Cape Girardeau County, and less than 1 ft thick in southern St. Louis County (fig. 89B). The Establishment appears to be absent in some sections in St. Charles County (fig. 81B), or it is present merely as a thin, 0.5-1 in. shale parting.

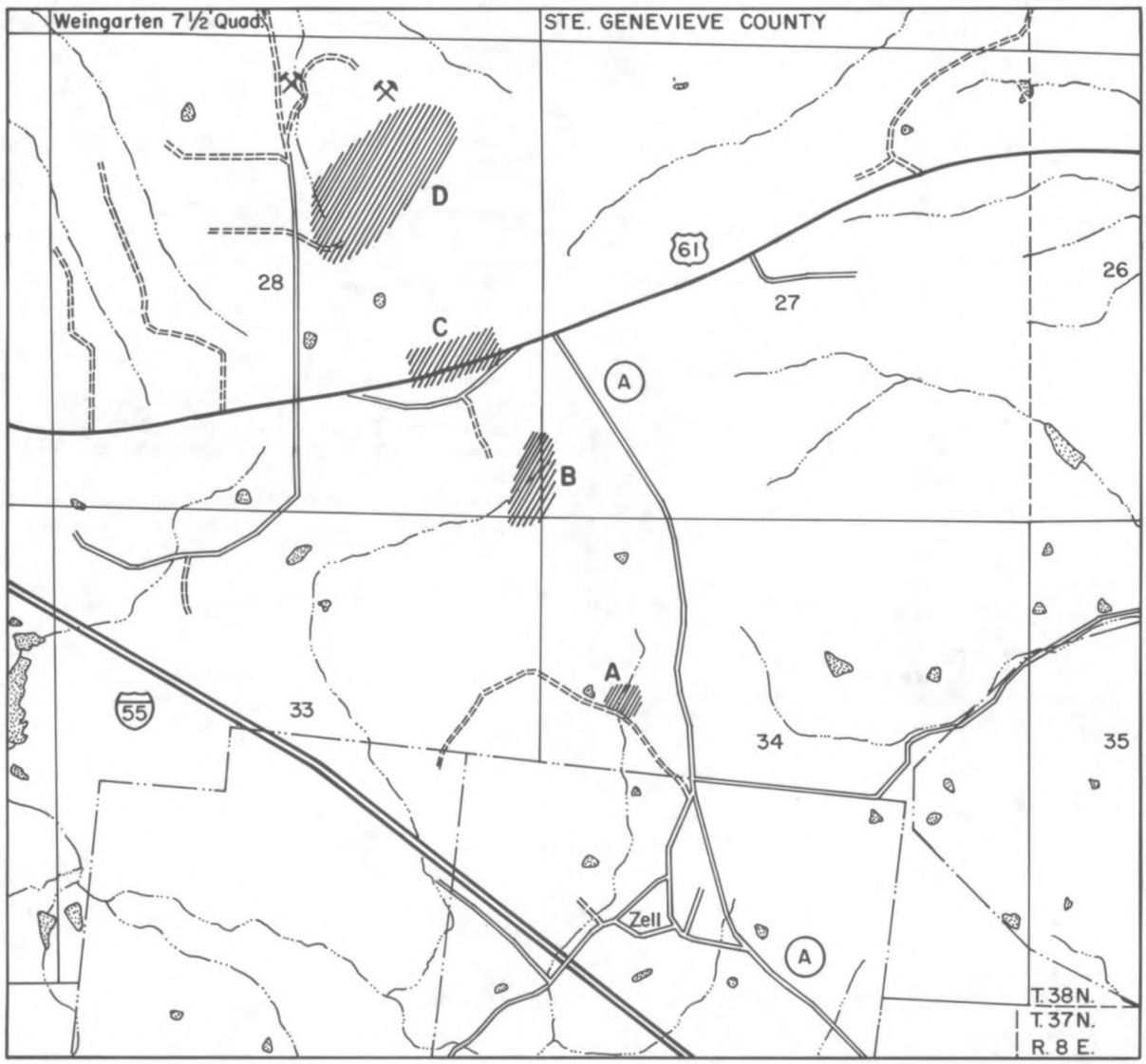
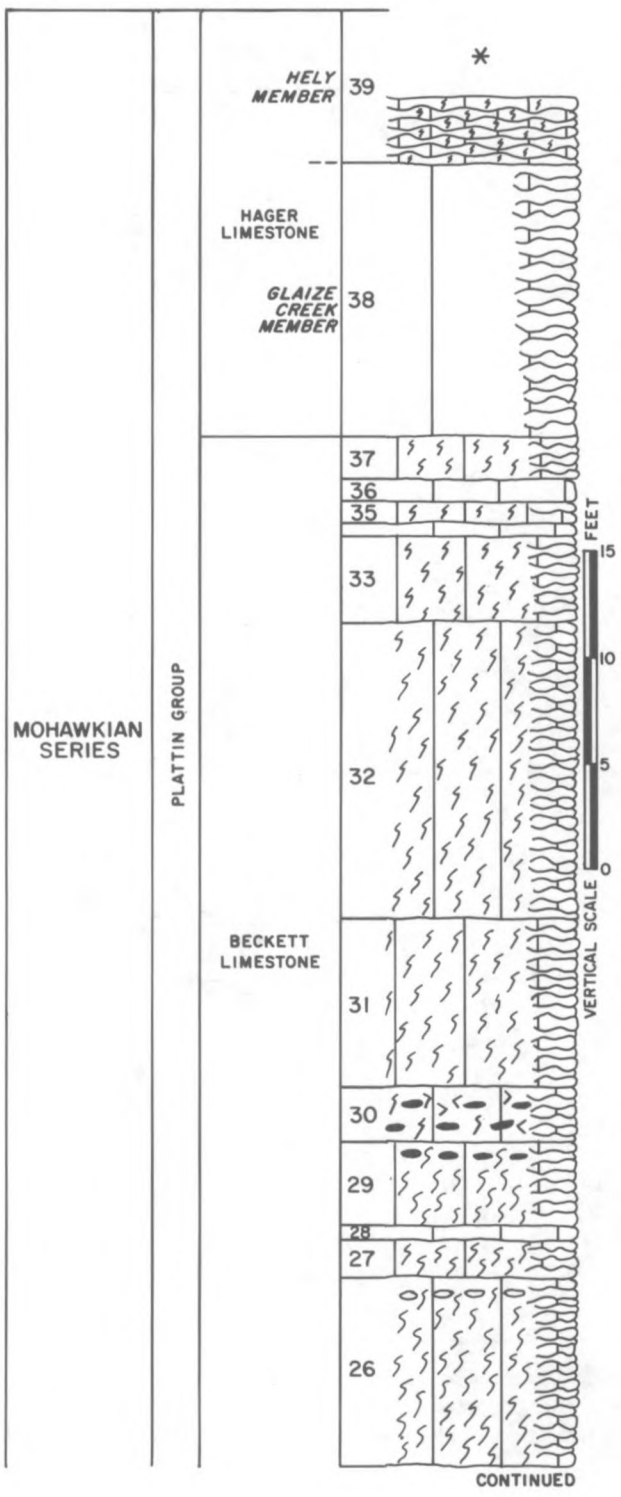


Figure 86. *Part of the Weingarten 7½' Quadrangle, showing the locations of the type sections of the* **(A) Establishment Shale Member of the Bloomsdale Limestone, (B) "Clement grainstone facies" of the Glaize Creek Member of the Hager Limestone, (C) Macy Limestone *(Hook and Zell Members)*,** *and* **(D) Beckett Limestone,** *Ste. Genevieve County, southeastern Missouri.*

At the type section, green shale dominates the unit; alternating thin 1-2 in. limestone beds occur between the thicker shale beds (fig. 87). Shale content decreases to around 25 percent in St. Louis County (fig. 82).

The Establishment Shale Member marks the top of the Bloomsdale Limestone. Directly above the Establishment is the "typical Plattin" burrowed mudstone and thin interbedded grainstones of the Beckett Limestone.



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
PLATTIN GROUP
Hager Limestone (16 ft)
Hely Member (3 ft)
39. Limestone, gray, lithographic, fossiliferous; contains cephalopods filled with quartz crystals; in thin beds with shale partings; weathers white. (3 ft)
Glaize Creek Member (13 ft)
38. Limestone, purplish-gray, medium- to coarse-grained calcarenite; thin to medium beds; weathers white (**Clement grainstone facies**). (13 ft)
Beckett Limestone (136 ft 4 in.)
37. Limestone, lithographic, dolomitic, burrowed, thin-bedded. (2 ft)
36. Limestone, laminated, medium- to coarse-grained calcarenite. (1 ft)
35. Limestone; like no. 43. (1 ft)
34. Limestone; fine-grained calcarenite. (8 in.)
33. Limestone; like no. 43. (4 ft)
32. Limestone, brown-gray, lithographic; mostly conglomeratic; thin beds with shale partings. (14 ft)
31. Limestone, brown-gray, lithographic; dolomite-filled burrows. (8 ft)
30. Limestone, brown, white-specked, lithographic, cherty, medium-bedded. (2 ft 6 in.)
29. Limestone; like no. 37, but cherty at top. (4 ft)
28. Limestone, white, fine-grained calcarenite. (8 in.)
27. Limestone; like no. 37, but heavily mottled with dolomite-filled burrows. (1 ft 6 in.)
26. Limestone, brown-gray, lithographic, partly burrowed, thin-bedded and shaly; thin conglomerate and calcarenite beds near top. (9 ft)

Figure 87. *Type section of the* **Establishment Shale Member of the Bloomsdale Limestone,** *W½ sec. 34, T. 38 N., R. 8 E., Ste. Genevieve County, Missouri. Adapted from a description by Templeton and Willman (1963, p. 231-232).*

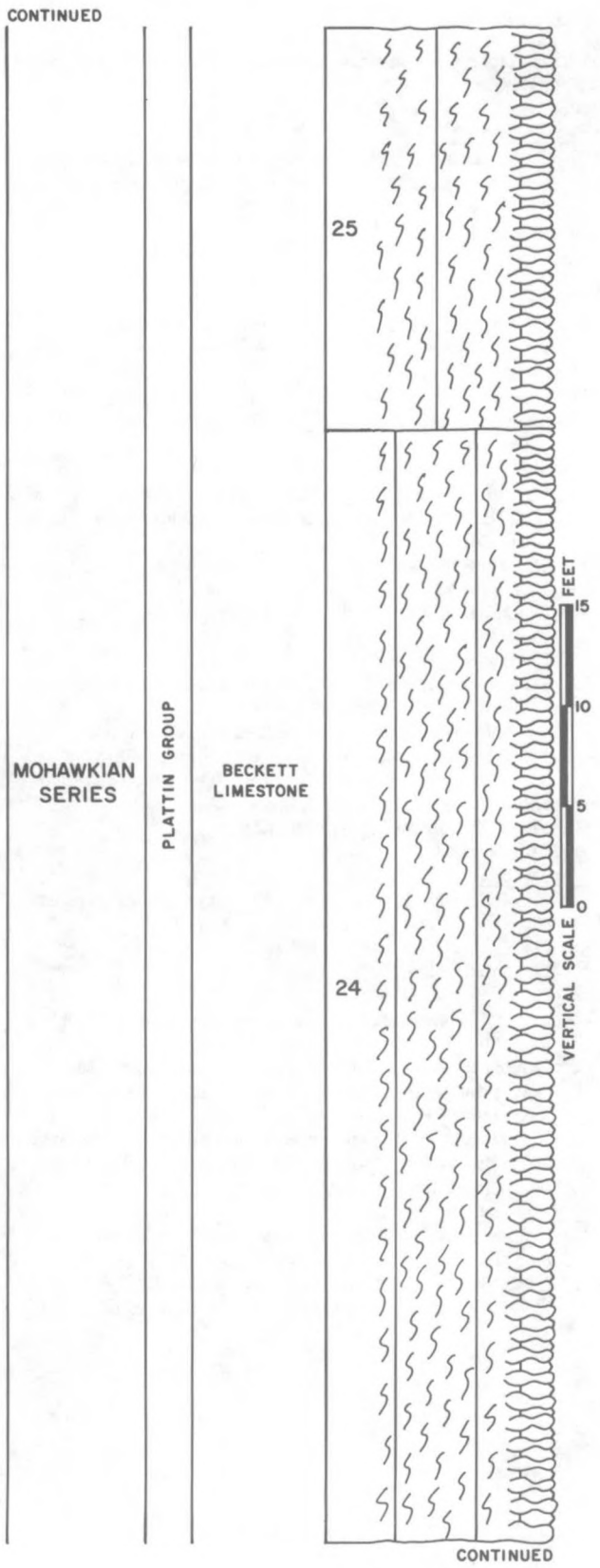


Figure 87 (cont.)

25. Limestone, brown-gray, lithographic, pure, medium-bedded; dolomite-filled burrows. (20 ft)
24. Limestone, brown-gray, lithographic; partly with dolomite-filled burrows; thin, irregular, rough-surfaced beds with thin shale partings; lower 10 ft is medium bedded, calcarenitic, without shale; *Tetradium* common at base. (55 ft)

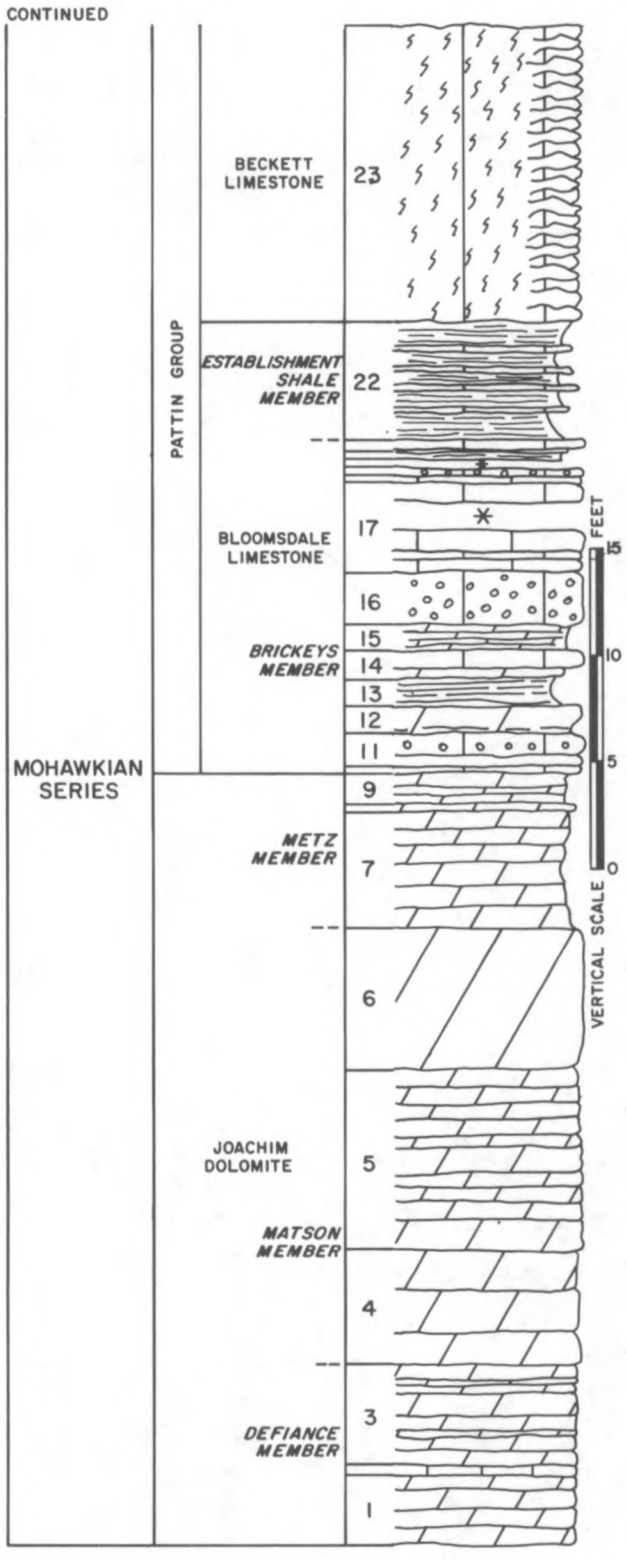


Figure 87 (cont.)

23. Limestone, purplish-brown, fine-grained, pure, thick-bedded. (13 ft 8 in.)

Bloomsdale Limestone (21 ft)

Establishment Shale Member (5 ft 6 in.)

22. Shale, calcareous, blue-green; a few thin argillaceous limestone beds; exposed beneath waterfall in pig-pen above bridge on E-W gravel road. (5 ft 6 in.)

Brickeys Member (15 ft 6 in.)

21. Limestone, gray-brown to gray, fine-grained, thin-bedded; argillaceous and mottled lower part. (6 in.)

Covered interval. (7 in.)

20. Limestone, light-gray to brown; upper half red-mottled, lithographic; lower half very fine-grained, conglomeratic, oolitic. (8-10 in.)
19. Dolomite, silty, thin-bedded. (3-4 in.)
18. Limestone, brown to dark-gray, lithographic; calcite flecks. (11 in.)

Covered interval. (1 ft 6 in.)

17. Limestone; as above; *Tetradium* in upper 1.5 ft; ripple-marked 1.5 ft below top; lower 6 in. massive brown fine-grained calcarenite. (2 ft 1 in.)
16. Limestone, brown, lithographic, oolitic, conglomeratic; *Tetradium*. (2 ft 6 in.)
15. Dolomite, silty; in thin beds with brown shale partings. (1 ft 2 in.)
14. Limestone, gray; carbonaceous mottling. (11 in.)
13. Shale, green; upper 6 in. contains thin beds of silty dolomite with carbonaceous flecks. (1 ft 6 in.)
12. Dolomite, silty, massive; thin-bedded at base. (1 ft 2 in.)
11. Limestone, brown to light-gray, lithographic, pure, fossiliferous; *Stromatocerium* at top; *Tetradium*, ostracodes; oolitic upper 1 ft 4 in. (1 ft 10 in.)
10. Limestone, brown, argillaceous. (2 in.)

Joachim Dolomite

Metz Member (8 ft)

9. Dolomite, silty, thin-bedded; "birdseye" structures; carbonaceous mottling; brown shale partings. (1 ft 9 in.)
8. Dolomite, oolitic, thin-bedded. (6 in.)
7. Dolomite; like no. 9. (5 ft 9 in.)

Matson Member (24 ft 6 in.)

6. Dolomite, finely porous, massive; large algal domes 4-ft below top. (7 ft)
5. Limestone, gray-brown, laminated, thin- to medium-bedded, heavily dolomite-mottled; weathers whitish; "birdseye" structures. (10 ft 6 in.)
4. Limestone, gray-brown, pure, strongly laminated, heavily dolomite-mottled; "birdseye" structures; contains brachiopods, trilobite fragments, ostracodes. (7 ft)

Defiance Member (11 ft)

3. Dolomite, buff, argillaceous, silty, thin- to medium-bedded; mud cracks and ripple marks. (6 ft 6 in.)
2. Limestone, gray, pure, laminated, massive. (7 in.)
1. Dolomite, very argillaceous, massive; base concealed. (4 ft.)

Beckett Limestone

Larson, 1951

Original description -- (Larson, 1951, p. 2049) "The name Beckett is applied to a formation of fine-textured calcite limestone having many layers of intraformational calcarenite and carbonate pebble conglomerate; nodular chert is common in the upper part."

Type section -- Larson (1951, p. 2049) stated, "The name is taken from the Beckett Hills in eastern Ste. Genevieve County. The type section, below [north of] the large road cuts along Missouri Highway 25 [now U.S. Highway 61] in the NW¼, Sec. 27 [mislocated; exposure is in the NE¼ sec. 28], T. 38 N., R. 8 E., Ste. Genevieve County (Loc. 18), has 117 feet of beds below the Hager and above the Bloomsdale. Much of the lower Beckett is concealed at the type section but its relation to bounding formations is clear." This is in the Weingarten 7½' Quadrangle (figs. 86 and 90).

Reference sections -- Although the exposure of the Beckett Limestone at its type section is poor, there are many excellent exposures of the Beckett Limestone that illustrate its characteristics and stratigraphic relationships. These include the roadcut on I-55 north of Joachim Creek (figs. 69, 70A, and 91A), roadcuts on Missouri Highway 30 at Weber Hill (fig. 68; NE¼ sec. 27, T. 43 N., R. 4 E.) and north of Cedar Hill (fig. 71), House Springs 7½' Quadrangle, and the roadcut on I-44, near Six Flags (fig. 72), all located under "Reference sections" of **Plattin Group**.

History of nomenclature

1951	**Larson**	**Beckett limestone**
1954	Twenhofel et al.	Beckett limestone
1961	Martin et al. (a)	Plattin formation (upper lower part)
1963	Templeton and Willman	Grand Detour Formation (lower part)
		Stillman Member
		Walgreen Member
		Dement Member
		Mifflin Formation (upper part)
		Briton Member
		Hazelwood Member

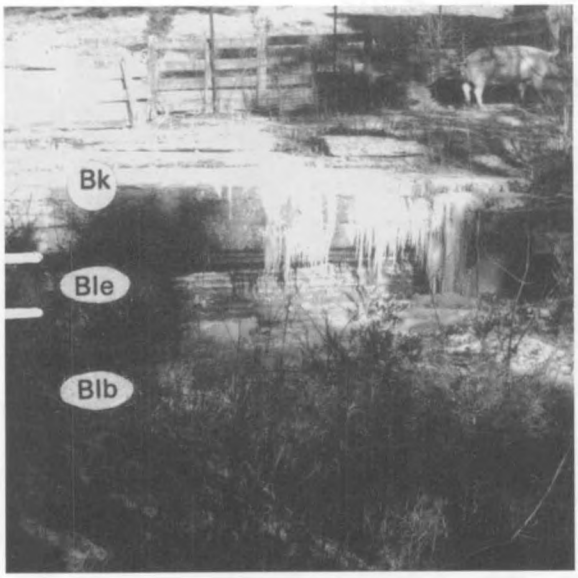


Figure 88. *Type section of the* **Establishment Shale Member of the Bloomsdale Limestone (Ble)**, *under small waterfall, W½ sec. 34, T. 38 N., R. 8 E., Ste. Genevieve County, Missouri (figs. 86 and 87).* **(Blb)** *Brickeys Member of Bloomsdale Limestone,* **(Bk)** *Beckett Limestone. Photograph by T.L. Thompson.*

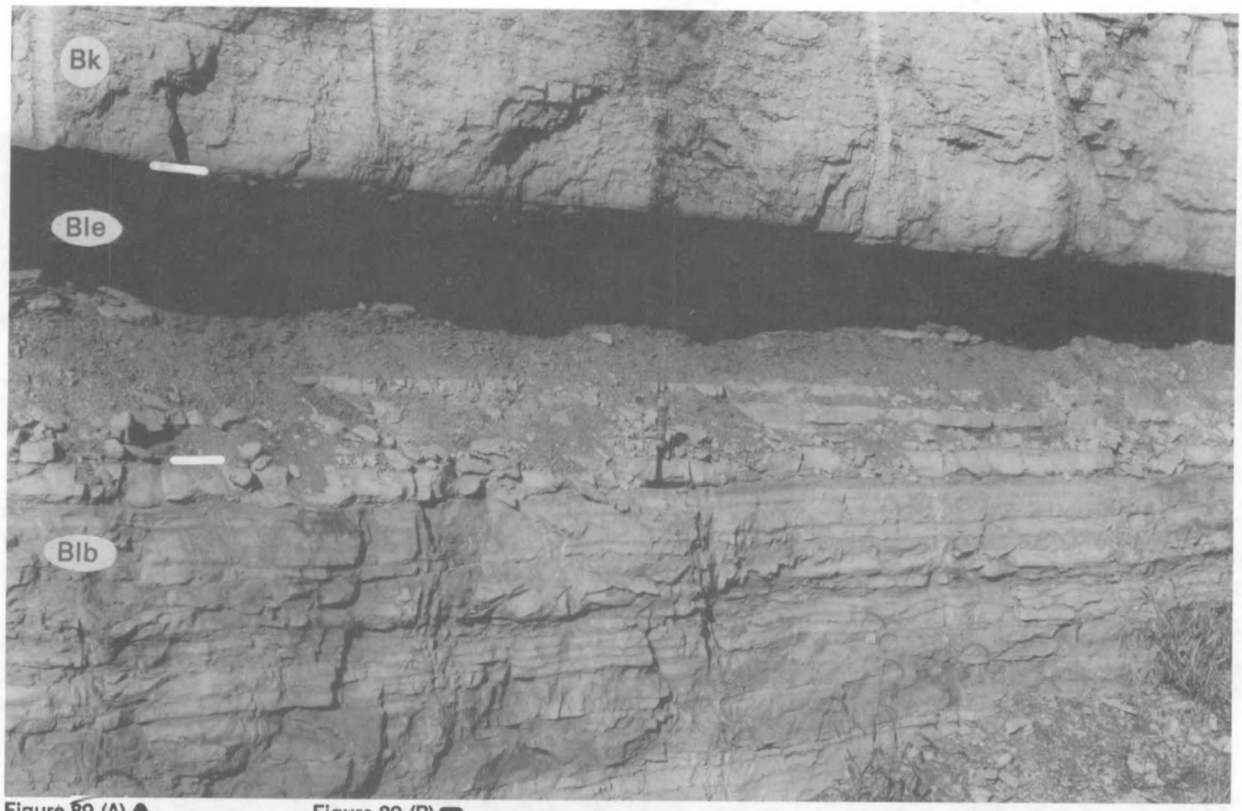


Figure 89 (A) ▲ Figure 89 (B) ▼

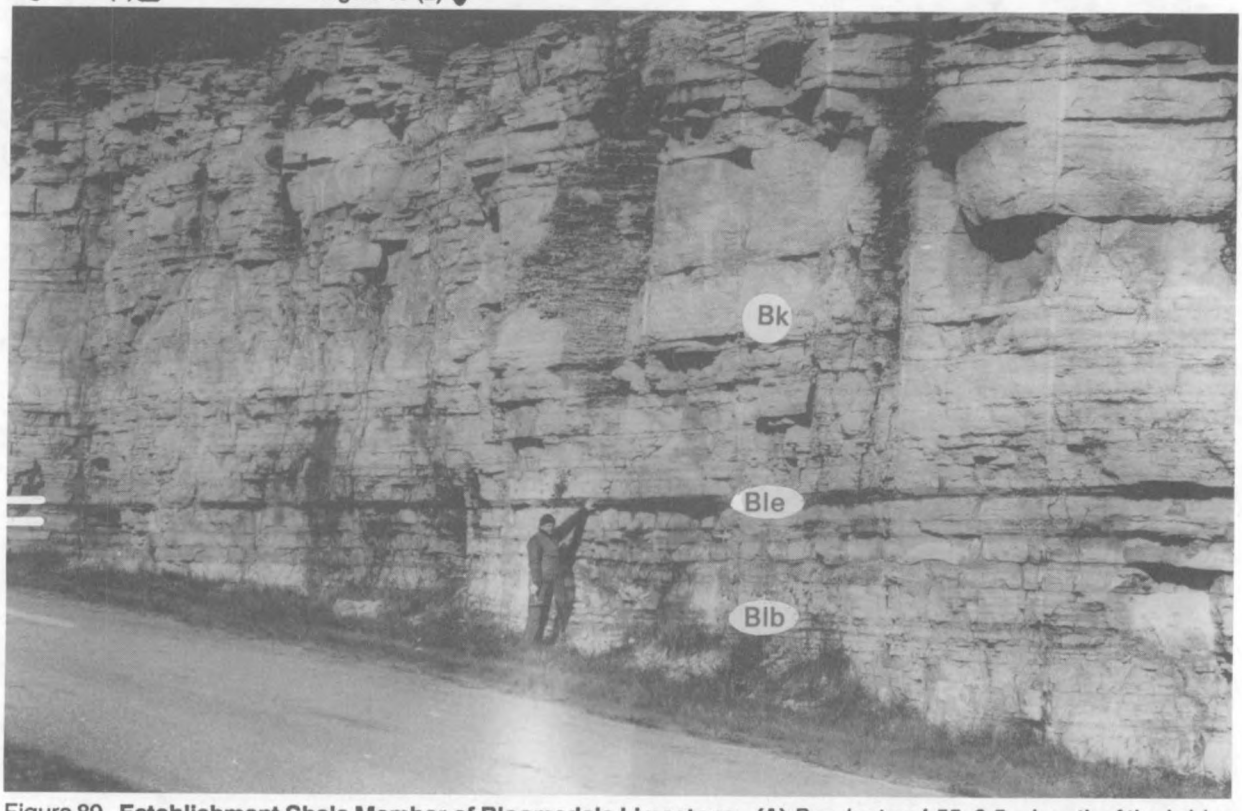
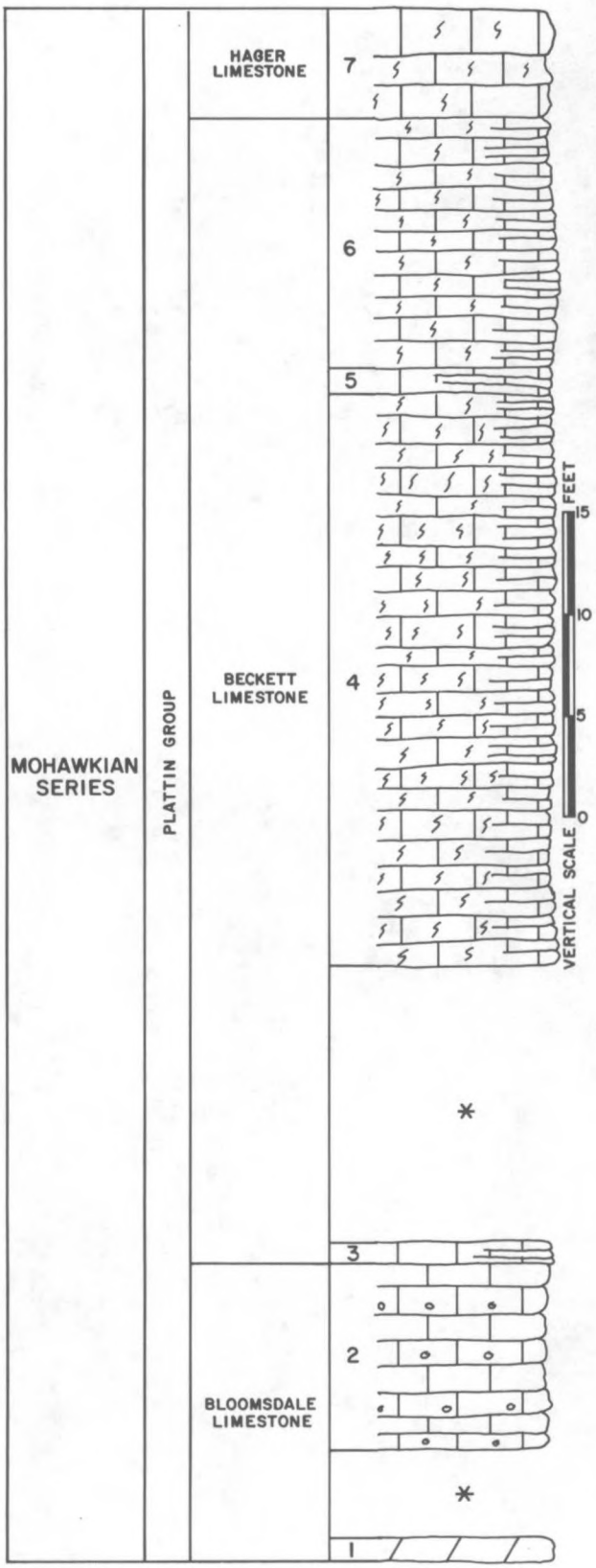


Figure 89. **Establishment Shale Member of Bloomsdale Limestone.** **(A)** *Roadcut on I-55, 0.5 mi north of the bridge over Joachim Creek (see fig. 69).* **(B)** *Roadcuts at Lewis Road exit of I-44, St. Louis County, Missouri (fig. 73).* **(Blb)** *Brickeys Member of Bloomsdale Limestone;* **(Ble)** *Establishment Shale Member of Bloomsdale Limestone;* **(Bk)** *Beckett Limestone. Photographs by T.L. Thompson.*



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

PLATTIN GROUP (148 ft)

Hager Limestone (12.5 ft)

7. Limestone, brown, medium-grained calcarenite, intraformational conglomerate at top. (12.5 ft)

Beckett Limestone (107 ft)

6. Limestone, pale yellowish-brown, finely crystalline, burrowed; contains *Actinoceras*, *Cryptophragnus*. (27 ft)
5. Limestone, pale yellowish-brown, fine-grained calcarenite; slabby. (2 ft)
4. Limestone, light yellowish-brown, finely crystalline, burrowed; contains *Favistella*. (58 ft)

Covered interval (28 ft)

3. Limestone, light yellowish-brown, finely crystalline; weathers rubbly. (2 ft)

Bloomsdale Limestone (29 ft)

2. Limestone, pale brown, finely crystalline; contains ostracodes and some oolites; poorly exposed. (17 ft)

Covered interval (10 ft)

1. Dolomite, buff. (2 ft+)

Figure 90. *Type section of the* **Beckett Limestone** *of the Plattin Group, NE¼ sec 28, T. 38 N., R. 8 E., Ste. Genevieve County, Weingarten 7½' Quadrangle (fig. 86). Adapted from description by Larson (1951).*

Figure 91 (A)

Figure 91 (B)

Figure 91. **Beckett and Hager Limestones.** **(A)** *Roadcut on I-55, 0.5 mi north of bridge over Joachim Creek (figs. 69 and 70).* **(B)** *Roadcut on frontage road at Highway M interchange with I-55 at Barnhart (figs. 77 and 95A). Both roadcuts in Jefferson County, Missouri, Herculaneum 7½' Quadrangle.* **(Bl)** *Bloomsdale Limestone;* **(Bk)** *Beckett Limestone;* **(Ha)** *Hager Limestone;* **(Ma)** *Macy Limestone. Photographs by T.L. Thompson.*

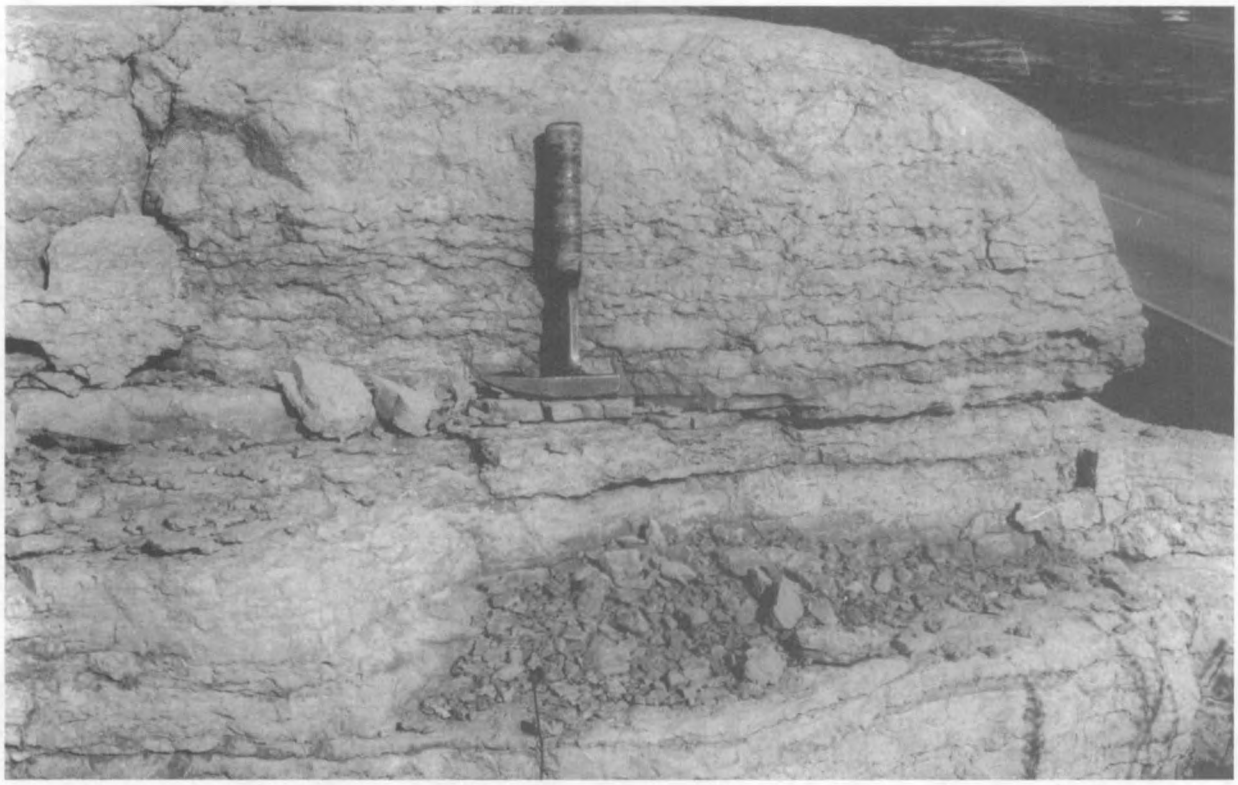


Figure 92. **Beckett Limestone** *in a roadcut on I-55 (fig. 91A) showing characteristic weathering into thin, incipient nodular beds. Compare with Beckett Limestone in figure 77. Photograph by T.L. Thompson.*

1978	Willman and Kolata	Grand Detour Formation (lower part) Stillman Member Cowen Member Mifflin Formation (upper part)
1982	Thompson	Plattin Limestone (upper lower part)
1986	McCart	Beckett Formation
1991	**Thompson (present report)**	**Beckett Limestone**

Remarks -- The Beckett Limestone is that part of the Plattin Group between the brown limestone and the shales of the underlying Bloomsdale Limestone and the overlying mudstone and grainstones of the Hager Limestone. The Beckett is lithologically "typical Plattin": nodular-bedded, burrowed gray mudstones interbedded with thin, even-bedded grainstones. Burrowing is abundant and obvious (fig. 77); when weathered, bedding is thin and very nodular (fig. 92).

The base of the Beckett Limestone is well marked, at the top of the Establishment Shale Member or the brown lithographic and oolitic limestone of the Brickeys Member of the Bloomsdale Limestone. The top of the Beckett can be identified easily where the unburrowed massive Glaize Creek Member of the overlying Hager Limestone is developed (fig. 91B); however, if the Glaize Creek Member is not present, the top of the Beckett is at the base of the Victory Member of the Hager Limestone (fig. 72).

Lithologically, the Beckett, composed of interbedded thick beds of burrowed nodular-bedded mudstone and thin grainstones, is nearly identical to the Macy Limestone (above the Hager Limestone). The distinction between these two formations is based on their positions, above (Macy Limestone) or below (Beckett Limestone) the Hager Limestone.

At one section the present author described a unit within the Beckett Limestone (beds 24 and 25, fig. 71) that could be misidentified as the Victory Member of the Hager Limestone. However, the limestone above this bed does not resemble the Macy Limestone, and can be identified as more Beckett Limestone.

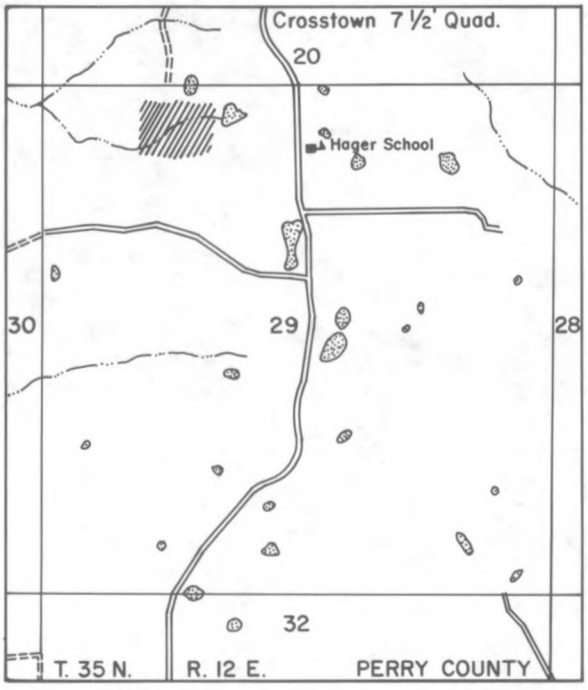


Figure 93. *Part of the Crosstown 7½' Quadrangle showing the location of the type section of the* **Hager Limestone** *of the Plattin Group, N½ NW¼ NW ¼ sec. 29, and N½ NE¼ NE¼ sec. 30, T. 35 N., R. 12 E., Ste. Genevieve County, Missouri.*

Hager Limestone

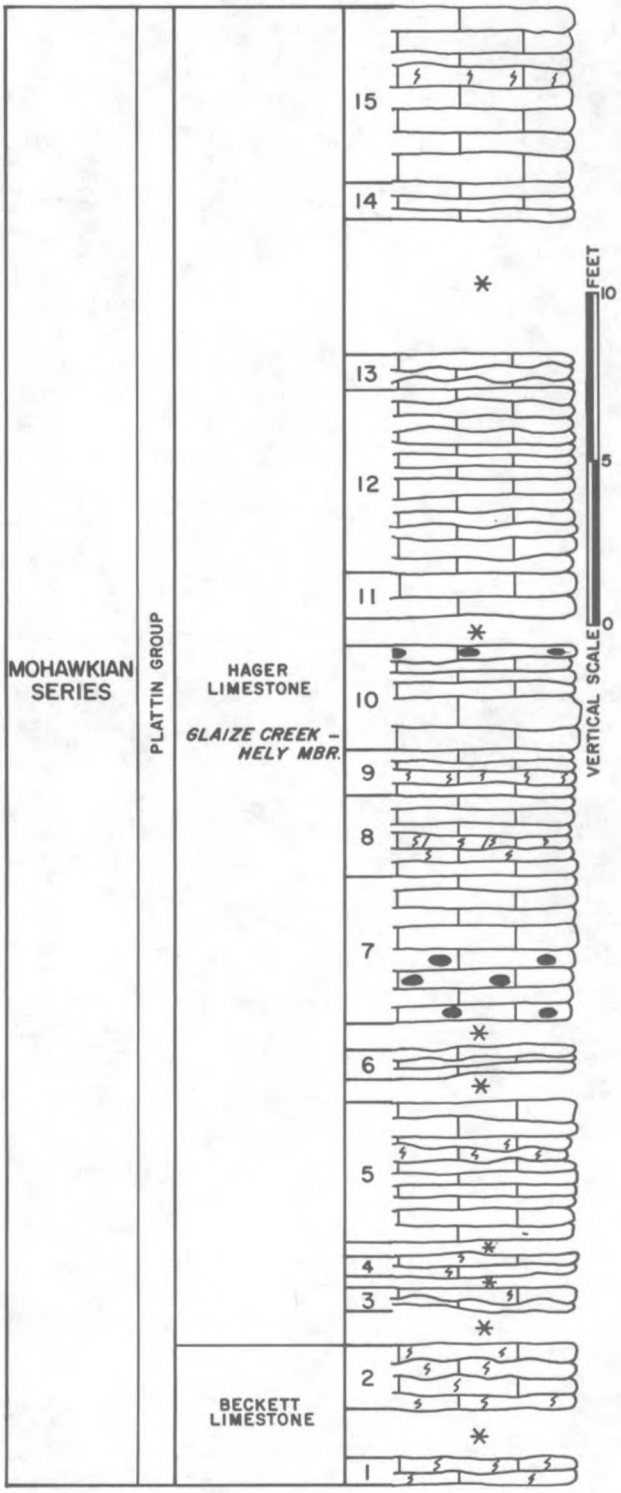
Larson, 1951

Original description -- (Larson, 1951, p. 2053-2054) "The name Hager refers to the generally fine-textured calcite rock between the underlying Beckett and succeeding Macy formations...The Hager shows three principal facies and their mutual gradations. The major part of the formation is slabby, light olive-gray calcitite with buff-weathering partings; calcarenite and calcilutite constitute lesser parts of the formation. The calcitite facies, principally developed in the southern thicker sections, grades northward into calcarenite. The calcilutite facies overlies the calcitite in the type area but grades laterally into calcarenite in the Ste. Genevieve County exposures.

"The type exposure of the formation, along a small stream extending northward from Hager School (Loc. 24), has 66 ft mainly of fine-textured calcitite in 2-6 inch slabby beds with chert nodules and layers here and there of intraformational carbonate pebble conglomerate, indicating diastems, and buff weathering shaly partings. The base of the formation is a 5-foot unit of yellowish brown medium-grained calcarenite; the light gray calcilutite facies is partly exposed for 5 ft at the top of the section."

Type section -- Larson (1951, p. 2054) located the type section "along a small stream extending northward from Hager School," and "Near Hager School in NW.¼, NW.¼ SEC. 29, T. 35 N., R. 12 E., PERRY COUNTY (LOC. 24)." Hager School is in the Crosstown 7½' Quadrangle in the center N½ N½ sec. 29 (figs. 93 and 94). A.C. Spreng (personal communication, 1987) measured this section and located it at N½ NW¼ NW¼ sec. 29, and N½ NE¼ NE¼ sec. 30, T. 35 N., R. 12 E., in a small creek bed leading to a farm pond, across the road and west-northwest from the abandoned Hager School building.

Reference sections -- The type section of the Hager Limestone consists of ledges and benches in the bottom of a streambed, and is not very useful for determining characteristics of the formation. The Hager Limestone is well developed, however, in many exposures in eastern and southeastern Missouri: 1) a



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
PLATTIN GROUP
About 9-10 ft of partially covered Macy Limestone
Hager Limestone (42.5 ft)
Victory Member of Hager Limestone (covered)
Hely-Glaize Creek Members (35 ft)
15. Limestone, gray, micritic, partially burrowed, fossiliferous (brachiopods). (4.2 ft)
Covered interval (1.3 ft)
14. Limestone, gray, micritic. (1.25 ft)
Covered interval (4.3 ft)
13. Limestone, gray, micritic, partially burrowed, fossiliferous, thin-bedded; forms steps in creek bed. (1.3 ft)
12. Limestone, gray, micritic; like no. 13. (5.5 ft)
11. Limestone, gray, micritic, uneven bedding. (1.6 ft)
Covered interval (0.7 ft)
10. Limestone, gray, micritic, hard, conchoidal fracture; brown chert nodules at top. (3.3 ft)
9. Limestone, gray, micritic, burrowed bed in middle. (1.7 ft)
8. Limestone, gray, micritic, thin-bedded, partly burrowed. (2.75 ft)
7. Limestone, gray and chocolate brown, burrowed in middle, thin 0.2-0.4 in. beds; contains small yellow-brown chert nodules. (4.3 ft)
6. Limestone, light gray, micritic, 3 beds; in middle of covered interval. (2.6 ft)
5. Limestone, gray, calcarenitic; brown dolomite-filled horizontal burrows; partly covered. (1.2 ft)
4. Limestone, gray, calcarenitic; brown dolomite-filled horizontal burrows; partly covered. (1.2 ft)
3. Limestone, calcarenitic, burrowed, partly covered. (2.2 ft)
Beckett Limestone
2. Limestone, gray and light-gray, micritic, intraclasts; brown chert nodules; rippled in part; thin 0.2-0.4 in. beds. (1.9 ft)
1. Limestone, gray, micritic, burrowed; small brown chert nodules. (0.6 ft.
Base of exposure

Figure 94. *Type section of the* **Hager Limestone** *(fig. 90), N½ NW¼ NW¼ sec. 29 and N½ NE¼ NE¼ sec. 30, T. 35 N., R. 12 E., Ste. Genevieve County, Missouri, Crosstown 7½' Quadrangle. Described by A.C. Spreng, 1987.*

roadcut on the west frontage road at the interchange of Highway M and I-55 (type section of Glaize Creek Member), SE¼ NW¼ sec. 30 (projected), T. 42 N., R. 6 E., Jefferson County, Missouri, Herculaneum 7½' Quadrangle (fig. 95A); **2**) roadcuts on I-44 near Six Flags amusement park (figs. 72 and 95B), **3**) roadcuts on I-55 north of Pevely (figs. 69, 70A, and 91A); and **4**) roadcuts on Missouri Highway 30 near Weber Hill, NE¼ sec. 27, T. 43 N., R. 4 E., Jefferson County, House Springs 7½' Quadrangle (fig. 68).

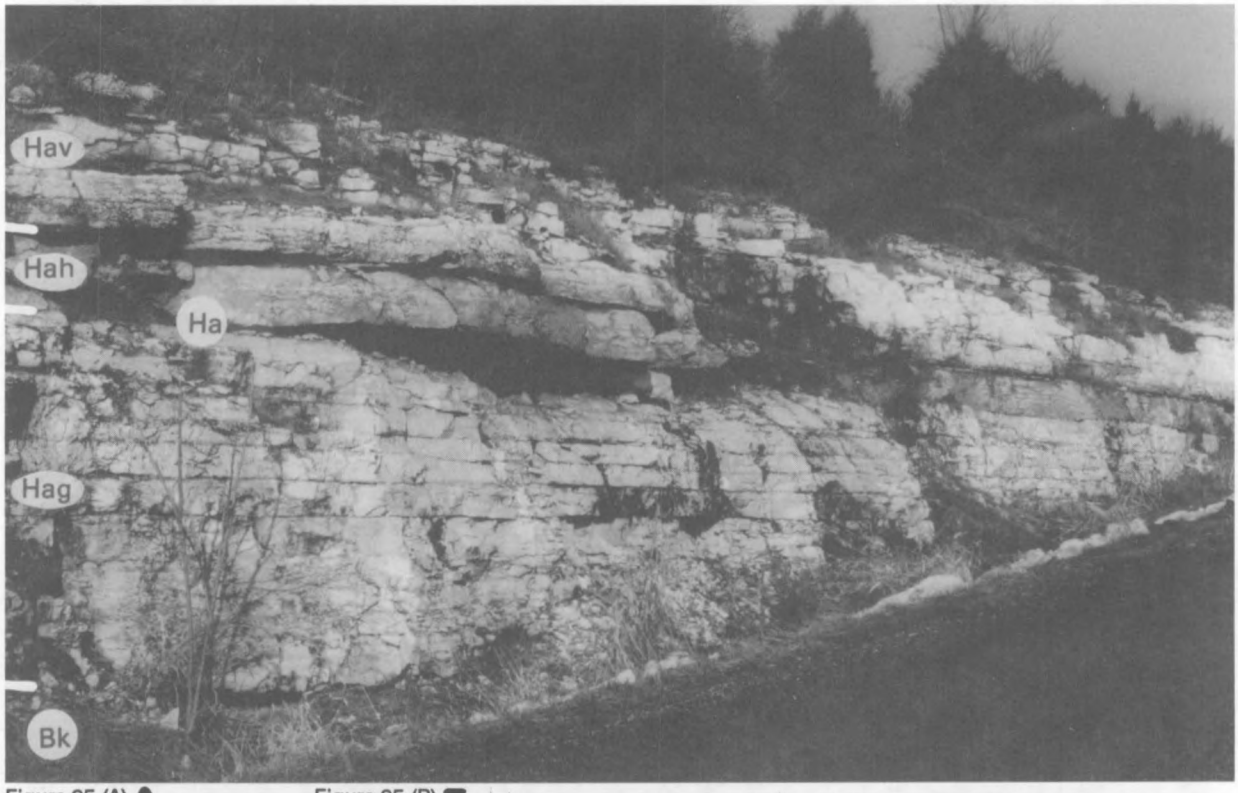


Figure 95 (A) ▲ Figure 95 (B) ▼

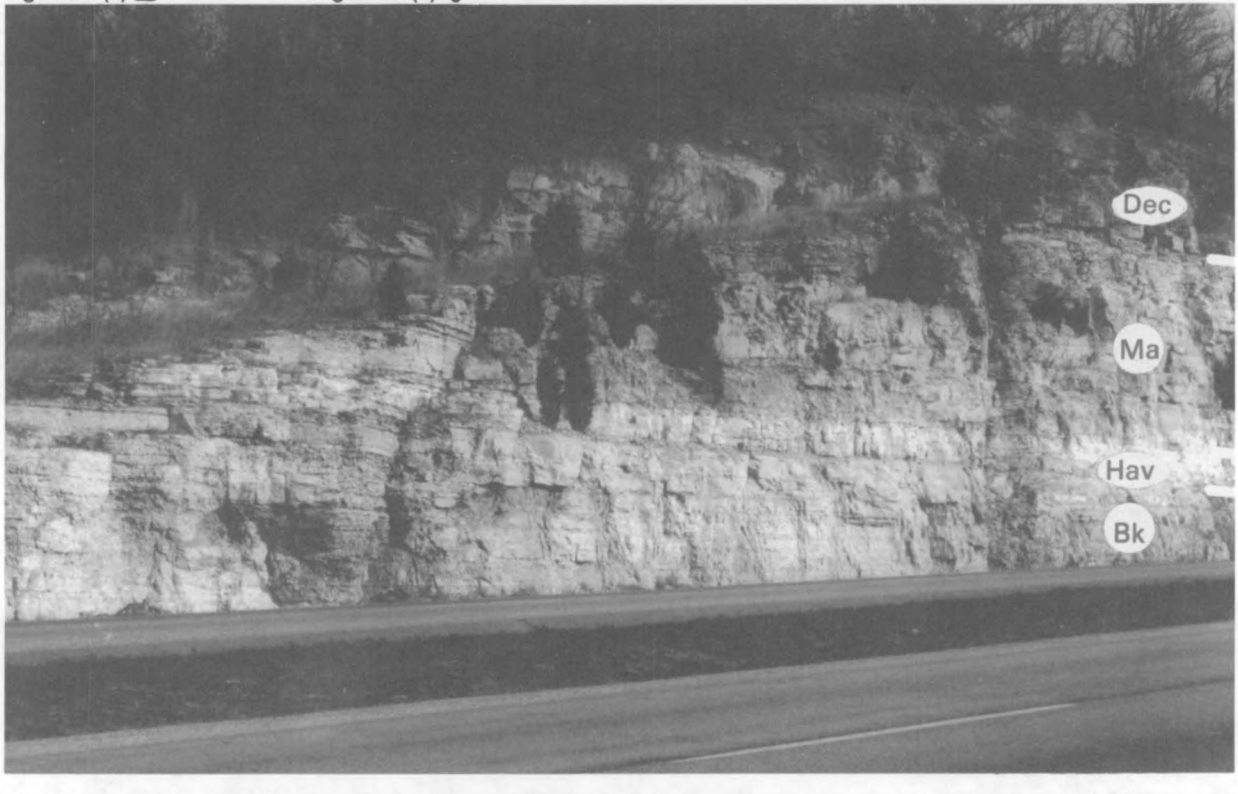


Figure 95. *The members of the* **Hager Limestone**. **(A)** *Roadcut on the northwest frontage road at the Highway M - I-55 interchange at Barnhart, Jefferson County, Missouri, type section of* **Glaize Creek Member** *(fig. 91B).* **(B)** *Roadcut on I-44 near Six-Flags, St. Louis County, Missouri (fig. 72).* **(Bk)** *Beckett Limestone;* **(Hag)** *Glaize Creek Member,* **(Hah)** *Hely Member, and* **(Hav)** *Victory Member of Hager Limestone;* **(Ma)** *Macy Limestone;* **(Dec)** *Decorah Group. Photographs by T.L. Thompson.*

Figure 96 (A) ▲ Figure 96 (B) ▼

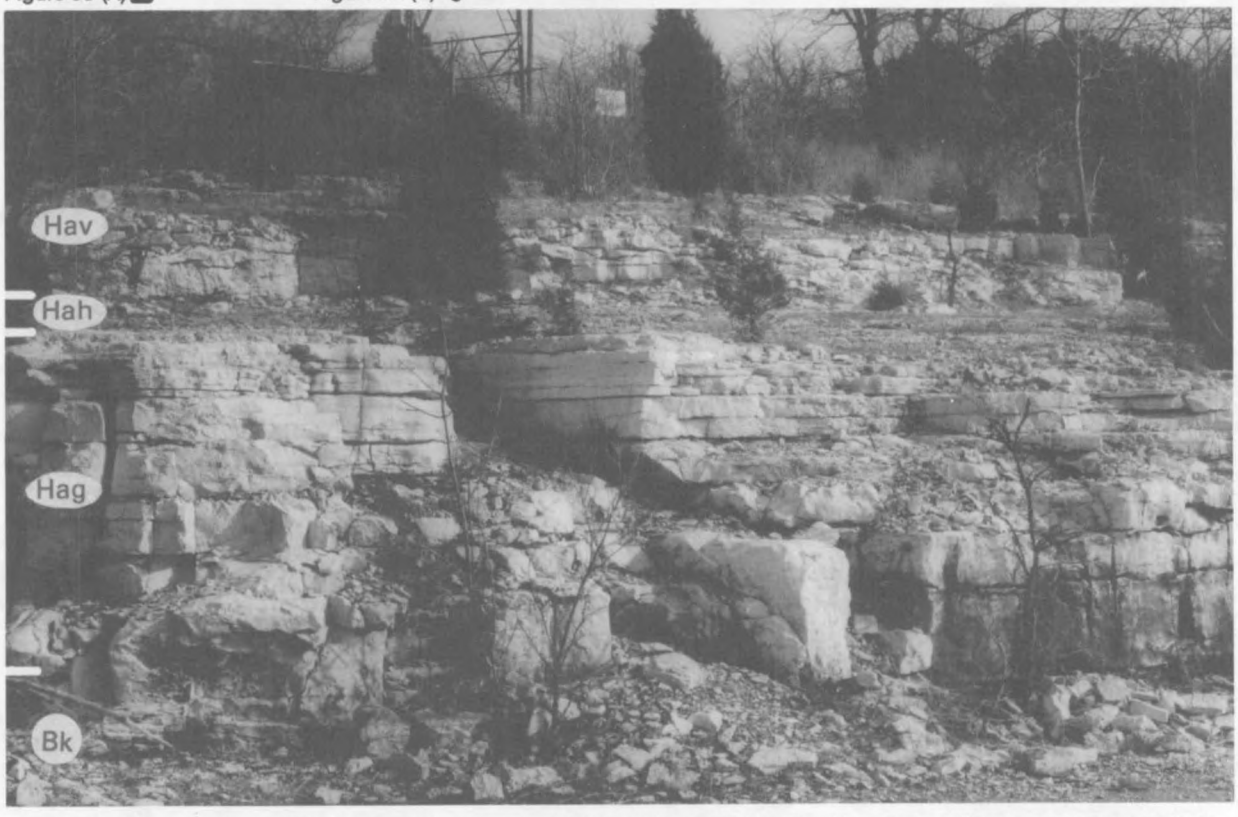


Figure 96. *The members of the* **Hager Limestone**. **(A)** *Roadcut on St. Charles County road F, 1.5 mi west of Defiance (fig. 74). Photograph by Myrna Rueff.* **(B)** *Upper part of the Fred Weber Crystal City quarry, NW¼ NW¼ sec. 16, T. 40 N., R. 6 E., Jefferson County, Missouri, Selma 7½' Quadrangle.* **(Bk)** *Beckett Limestone;* **(Hag)** *Glaize Creek Member,* **(Hah)** *Hely Member, and* **(Hav)** *Victory Member of Hager Limestone;* **(Ma)** *Macy Limestone. Photograph by T.L. Thompson.*

An unusual development of the Hager Limestone is in a roadcut on St. Charles County road F, 1.5 mi west of Defiance (figs. 74 and 96A). The basal Hager is represented by the very distinctive Hely Member, which is overlain by the Glaize Creek Member, then another tongue of the Hely Member, and the whole is capped by a thin, but well developed Victory Member.

Two of the best exposures are in the upper part of the Fred Weber quarry, southeast of Crystal City (fig. 96B), NW¼ NW¼ sec. 16, T. 40 N., R. 6 E., Jefferson County, Selma 7½' Quadrangle, and the Georgia Marble Company quarry at Rush Island, center W½ W½ sec. 4, T. 39 N., R. 7 E., adjacent to the Rush Island electric generating plant, Jefferson County, Missouri, Selma 7½' Quadrangle.

Most of these exposures are also discussed under "Reference sections" of the **Glaize Creek, Hely**, and **Victory Members of the Hager Limestone.**

History of nomenclature

1951	**Larson**	**Hager limestone**
1954	Twenhofel et al.	Hager limestone
1961	Martin et al. (a)	Plattin formation (middle part)
1963	Templeton and Willman	Grand Detour Formation (part) Victory Member Hely Member Clement Member
1978	Willman and Kolata	Grand Detour Formation Forreston Member (lower part)
1982	Thompson	Plattin Limestone (middle part)
1986	**McCart**	**Hager Formation** **Victory Member** **Hely Member** **Clement Member**
1988	**Thompson and Spreng**	**Hager Limestone** **Victory Member** **Hely Member** **Glaize Creek Member** **"Clement grainstone facies"**
1991 (in press)	**McCart and Spreng**	**Hager Limestone** **Victory Member** **Hely Member** **Clement Member**
1991	**Thompson (present report)**	**Hager Limestone** **Victory Member** **Hely Member** **Glaize Creek Member (formally proposed)** **"Clement grainstone facies"** **Hager Limestone** **Victory Member (only; where lower two members are absent)** **Plattin Limestone (middle part; where Hager Limestone cannot be identified)**

Remarks -- Larson (1951) stated that the Hager is composed of three principal intergrading facies: (1) slabby, light olive-gray calcite with buff-weathering partings, (2) calcarenite, and (3) calcilutite. He also stated that (p. 2054)

> "The Hager is differentiated from the Beckett formation and the lower member of the succeeding Macy formation by the **absence of fucoids** [bold type mine]."

McCart (1986) and McCart and Spreng (1991, in press) made detailed studies of the Hager Limestone of western Illinois and eastern Missouri, and defined the three facies of the Hager as members, two of which had been originally proposed by Templeton and Willman (1963) as members of the "Grand Detour Formation" (fig. 78); the **Hely Member** (Larson's "slabby, light olive-gray calcite," a thin-, nodular-bedded, burrowed, argillaceous, calcareous mudstone similar in appearance to the Beckett Limestone) below, and the **Victory Member** (the calcilutite). The third, basal member (named and proposed formally in this

report) is the **Glaize Creek Member**, which is a mudstone similar to the Victory in much of east-central Missouri. At some, but not all, exposures the Hager also contains grainstone beds, identified as the **"Clement Member of the Grand Detour Formation"** by Templeton and Willman (1963), as the **"Clement Member of the Hager Formation"** by McCart (1986). The present study recognizes this calcarenite as a facies of the lower member of the Hager Limestone, and identifies it as the **"Clement grainstone facies" of the Glaize Creek Member of the Hager Limestone.** The "Clement facies" (of the Glaize Creek) and the Hely Member were described by McCart as "lithologically interbedded" at some exposures; however, where the Glaize Creek is thick-bedded mudstone, the Glaize Creek can easily be mistaken for the overlying Victory Member.

McCart (1986) stated that the "Clement Member" (**Glaize Creek** in this report) is

> "...a medium to coarse-grained calcarenite which grades in color from gray (north), light olive gray, pinkish whitish gray (mistaken for the Victory Member), light brownish gray to brownish gray (extreme southern exposures). Where thick it occurs in 3-24 cm beds, only rarely thicker."

The **Hely Member** is

> "...a fine-grained to sublithographic limestone. It is thinly bedded with argillaceous, organic, and/or dolomitic partings depending on the locality."

and the **Victory Member** is a

> "...distinctive, white or light-colored lithographic to sublithographic limestone (mudstone). It is white in the northern outcrops, light gray to gray in southern outcrops and buff-colored where weathered...The Victory member is always found at the top of the Hager Formation wherever the Hager is exposed. It is underlain by the Hely and Clement members. Normally, the slabby, darker Hely underlies the Victory, in some cases the calcarenitic Clement is found directly below the Victory."

Although in some exposures the Glaize Creek and Hely facies are "lithologically interbedded," in most outcrops in east-central Missouri, from St. Charles County south to Ste. Genevieve County, the Glaize Creek Member is very similar lithologically to the Victory and is characterized by large orthoconic nautiloids (fig. 97) in the upper part and a zone of large discrete brown to tan subspherical chert nodules in the lower part. The Glaize Creek lies beneath a thin-bedded nodular dark gray limestone (Hely), which is below the Victory. This succession, Glaize Creek, Hely, and Victory, therefore, constitutes the **Hager Limestone**, which can be recognized at most sections that expose rocks of the middle and upper Plattin Group in east-central and southeastern Missouri.

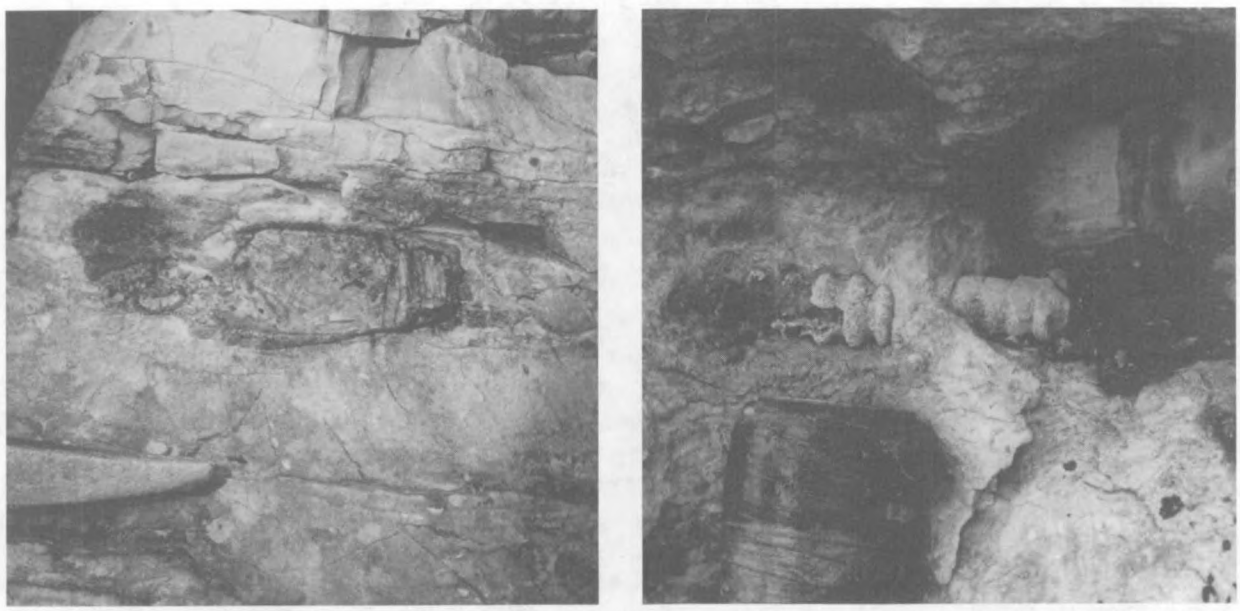


Figure 97. *Two specimens of* actinocerid nautiloids *in the upper part of the* **Glaize Creek Member of the Hager Limestone**, *in a roadcut on I-55 south of Zell, Ste. Genevieve County, Missouri. Photographs by T.L. Thompson.*

In some exposures the lithologies of the Glaize Creek and Hely are interbedded (figs. 74 and 96A); elsewhere the Glaize Creek may be represented only by the "Clement grainstone facies" (figs. 69 and 91A), or is not present (fig. 72). At the latter section, only the Victory Member of the Hager can be recognized. If the Hely is present, it cannot be distinguished from the underlying lithologically similar Beckett Limestone.

Both the overlying Macy Limestone and underlying Beckett Limestone are "typical Plattin" limestones, burrowed, nodular bedded mudstones. The Hager is distinct in that the upper and lower members are mainly unburrowed mudstones to grainstones. Because they are unburrowed and therefore do not weather to a nodular and pitted surface as do the Macy and Beckett, individual beds of the Glaize Creek and Victory Members appear to be thicker and more massive (fig. 91B).

Where fully developed, therefore, the Hager comprises a basal, light-gray, thick-bedded, unburrowed mudstone to grainstone usually containing large brown chert nodules (Glaize Creek); a middle, burrowed, wavy, thin- to medium-bedded ("typical Plattin") mudstone (Hely); and an upper, light-gray to nearly white, unburrowed, thick-bedded mudstone to very fine grainstone (Victory).

Glaize Creek Member of Hager Limestone

Thompson and Spreng, 1988; Thompson, 1991 (present report)

Description -- The Glaize Creek Member is a medium- to thick-bedded calcareous mudstone, often interbedded with thinner fine grainstones, with usually one bed of discontinuous large (6-8-in.) brown chert nodules near the base. It is unburrowed, and weathers to smooth light gray to nearly white ledges. The "Clement grainstone facies" was defined by Templeton and Willman (1963, p. 86)as: "...purplish gray, medium- to coarse-grained, pure calcarenite. Where thick it occurs in 2- to 15-inch beds that locally are cross-bedded. It grades to calcarenitic limestone at Cape Girardeau, southeastern Missouri, at places in southeastern Minnesota and adjoining areas, and at Kentland, northwestern Indiana."

Type section -- The type section of the Glaize Creek Member of the Hager Limestone is a roadcut on the northwest frontage road at the junction of Jefferson County road M and I-55, SE¼ NW¼ sec. 30 (projected), T. 42 N., R. 6 E., Jefferson County, Missouri, Herculaneum 7½' Quadrangle (figs. 91B, 95A, 98, and 99). Because the name "Barnhart" was preempted by Cooper (1956) for rocks of the Decorah Group in Missouri, the name was taken from Glaize Creek, a southeast-flowing creek paralleling Highway M, less than 0.1 mi south of the type section.

The "Clement grainstone facies" of the Glaize Creek Member (Templeton and Willman,1963, p. 86) was "...named for Clement Station, Ste. Genevieve County, southeastern Missouri. The type section is half a mile north of Zell..." (p. 230) "18. Zell Section - Compiled from exposures along a ravine just north of the village of Zell, Ste. Genevieve County, Missouri (W½ 34, 38N-8E, Weingarten Quad.). Type sections of Establishment Member of Mifflin Formation and Clement Member of Grand Detour Formation. The top of the section is about a quarter of a mile north (upstream) of the east-west road crossing the ravine." This section (fig. 87) is illustrated under "Type section" of **Establishment Shale Member of Bloomsdale Limestone.**

Reference sections -- The Glaize Creek Member of the Hager Limestone is well developed in the upper part of the Fred Weber Crystal City quarry, NW¼ NW¼ sec. 16, T. 40 N., R. 6 E., Selma 7½' Quadrangle (fig. 96B) and in the roadcut on St. Charles County road F, 1.5 mi west of Defiance (fig. 96A). It is present, but not as obvious, in the first roadcut north of Joachim Creek on I-55 north of Pevely (figs. 69 and 91A), described under "Reference sections" of the **Plattin Group**, and in the first roadcut on I-55 south of the type section.

Other excellent exposures of the Glaize Creek Member include roadcuts on Highway 30 northeast of House Springs (Weber Hill, NE¼ sec. 27, T. 43 N., R. 4 E., fig. 68) and near the town of House Springs, just east of Highway 30, SW¼ SE¼ sec. 33 (projected), T. 43 N., R. 4 E., House Springs 7½' Quadrangle, Jefferson County, Missouri.

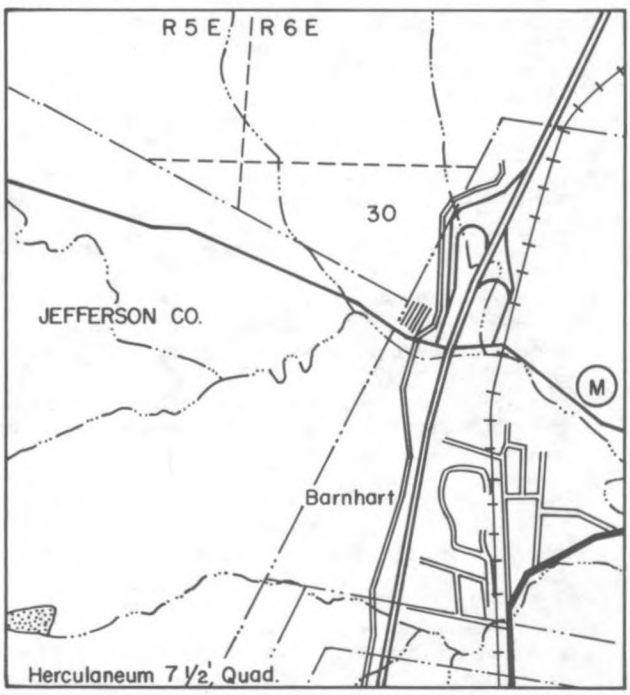


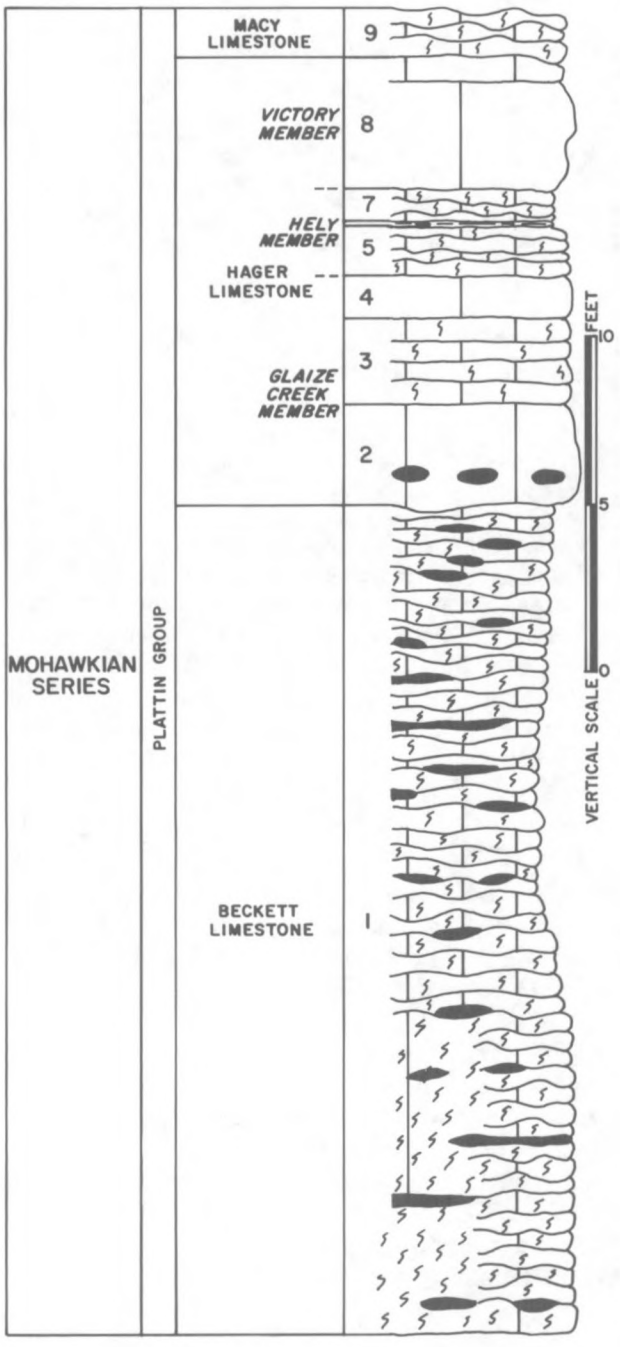
Figure 98. *Part of the Herculaneum 7½' Quadrangle showing the location of the type section of the* **Glaize Creek Member of the Hager Limestone**, *SE¼ NW¼ sec. 30 (projected), T. 42 N., R. 6 E., Jefferson County, Missouri (figs. 91B and 95A).*

History of nomenclature

1951	Larson	Hager limestone (lower part)
1961	Martin et al. (a)	Plattin formation (middle part)
1963	**Templeton and Willman**	**Clement Member of Grand Detour Formation**
1978	Willman and Kolata	Forreston Member of Grand Detour Formation (lower part)
1982	Thompson	Plattin Limestone (middle part)
1986	**McCart**	**Clement Member of Hager Formation**
1988	**Thompson and Spreng**	**Glaize Creek Member of Hager Limestone "Clement grainstone facies"**
1991	**Thompson (present report)**	**Glaize Creek Member of Hager Limestone (formally proposed) "Clement grainstone facies"**
1991(in press)	McCart and Spreng	Clement Member of Hager Limestone

Remarks -- The **Glaize Creek Member of the Hager Limestone** is a prominent unit in most outcrops, standing out as a very light-gray, massive and smoothly bedded calcareous mudstone and/or grainstone. It is usually unburrowed, or only weakly so. A distinctive straight actinocerid nautiloid (fig. 97) is common in the upper beds of the Glaize Creek, but has not been found in the Victory Member. Although not everywhere as prominent as the Victory Member above, the Glaize Creek is lighter and more massive than the upper beds of the underlying Beckett Limestone and the immediately overlying Hely Member of the Hager Limestone. Where the Glaize Creek is thickest, in Jefferson and northern Ste. Genevieve counties, a discontinuous bed of large subspherical brown to tan chert nodules occurs in the lower part.

In the exposure on St. Charles County road F (fig. 96A), the Glaize Creek Member, although thick and well developed, has the characteristic lithology of the Hely Member above and below it. The base of the Hager is at the base of the lower Hely bed. This relationship supports McCart's ideas on the interbedded nature of these two facies.



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
PLATTIN GROUP

Macy Limestone (1 ft)

9. Limestone, like no. 1. (1 ft)

Hager Limestone (13 ft 8 in.)

Victory Member (4 ft)

8. Limestone, like no. 2; one 3-ft bed with three thinner beds at top, small chert nodules in top bed. (4 ft)

Hely Member (2 ft 6 in.)

7. Limestone, like no. 5 at base, grades upward to "Victory-like" bed at top. (1 ft 1 in.)
6. Shale, gray, as thin parting. (1-2 in.)
5. Limestone, light-blue-gray, sublithographic; finely burrowed (¼ in.); thin wavy incipient beds on single bed. (1 ft 4 in.)

Glaize Creek Member (7 ft 3 in.)

4. Limestone, light-tan, light-gray at top, micritic to slightly calcarenitic, like no. 3; single bed; 4-in. stylolite-bounded bed in lower part. (1 ft 2 in.)
3. Limestone, very light-tan, lithographic; four even 6-8-in. beds; 1/8-¼-in. widely spaced vertical burrows. (2 ft 6 in.)
2. Limestone, very light-gray, lithographic, unburrowed, single bed; zone of subspherical, 2-4-in. brown chert nodules 1 ft above base; base irregular; contact with underlying Beckett Limestone abrupt. (3 ft 6 in.)

Beckett Limestone (25 ft)

1. Limestone, light-gray, lithographic, highly burrowed; weathers to thin porous wavy to nodular beds; scattered discontinuous thin beds and zones of nodules of brown chert; ½-2-in. irregular calcarenite beds throughout, often with pebble conglomerate in lower part. (25 ft)

Figure 99. *Type section of the* **Glaize Creek Member of the Hager Limestone** *(figs. 91B, 95A, and 98), junction of Jefferson County road M and I-44, Missouri. Described by T.L. Thompson, 1987.*

Hely Member of Hager Limestone

Templeton and Willman, 1963; Thompson, 1991 (present report)

Original description -- (Templeton and Willman, 1963, p. 86) "The Hely Member consists of limestone that is argillaceous, lithographic, occurs in 3- to 15-inch beds separated by shale partings or by prominent argillaceous dolomitic bands next to bedding surfaces. Much of the limestone is very calcarenitic, or contains thin calcarenite layers that are locally cherty, rarely dolomite mottled, and generally nonfucoidal. It grades to chalky or fine-grained dolomite in part of central northern Illinois and in central southern Wisconsin."

Type section -- Templeton and Willman (1963, p. 86) stated, "The Hely Member of the Grand Detour Formation is here named for Hely's upper quarry, which, with the adjoining Federal and Marquette quarries, constitutes the type section, at the southern outskirts of Cape Girardeau, Missouri. The name also has been spelled Healy (Ulrich, 1939, p. 108), but a photograph on which the name is visible (Buckley and Buehler, 1904, pl. 15) is authority for the spelling used." (p. 233) "21. Cape Girardeau South Section - Composite section of exposures in three quarries -- the abandoned Hely quarry (northernmost), Federal Stone Company quarry, and the Marquette Cement Company quarry -- south of Cape Girardeau, Missouri (NW NE and SE NW 18, 30N-14E., Cape Girardeau Quad.). Type section of Hely Member of Grand Detour Formation."

The Federal and Marquette quarries have been combined and now constitute the Lone Star Industries, Inc. quarry (figs. 100, 101, and 102A). The Hely quarry is immediately north of the Lone Star quarry.

Reference sections -- The Hely Member of the Hager Limestone is well exposed in a roadcut on the frontage road north of the junction of I-55 and Highway M, Jefferson County (fig. 95A), in the upper part of the Fred Weber Crystal City quarry (fig. 96B), and in the roadcut on St. Charles county road F (fig. 96A), all of which are described under "Reference sections" of the **Hager Limestone** and **Glaize Creek Member of Hager Limestone.**

History of nomenclature

1951	Larson	Hager limestone (middle part)
1961	Martin et al. (a)	Plattin formation (middle part)

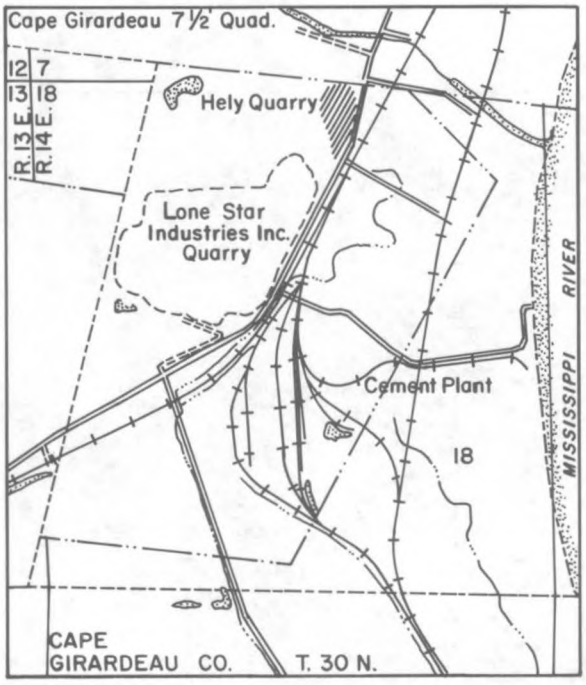


Figure 100. *Part of the Cape Girardeau 7½' Quadrangle, showing the location of the type section of the* **Hely Member of the Hager Limestone** *in a quarry adjacent to the Lone Star Industries, Inc. quarry.*

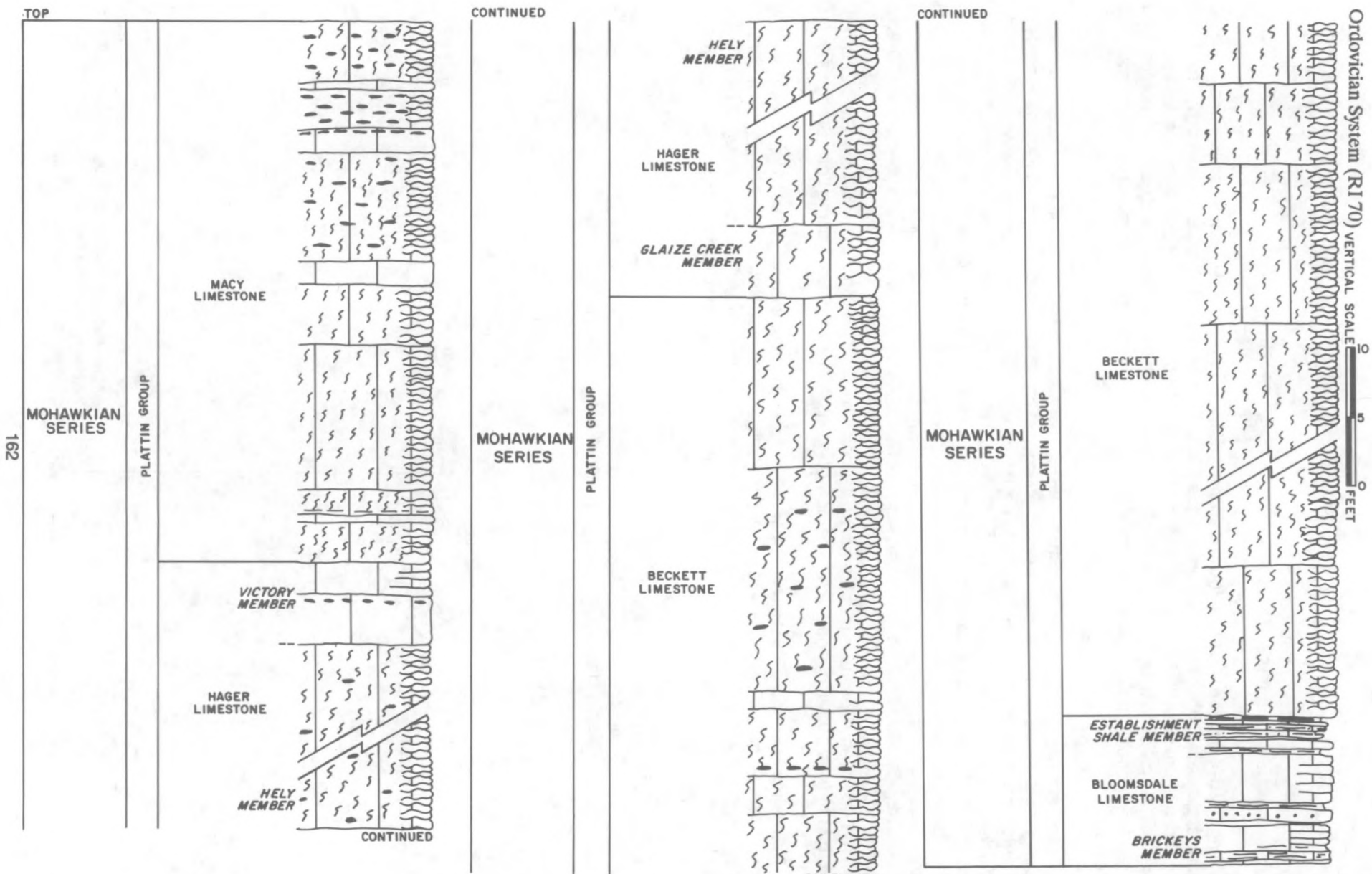


Figure 101. **Plattin Group** *exposed in the northeast wall of the Lone Star Industries, Inc. Quarry (fig. 100), adjacent to the type section of* **Hely Member of the Hager Limestone**. *Adapted from a description by Templeton and Willman (1963).*

Figure 102 (A)

Figure 102 (B)

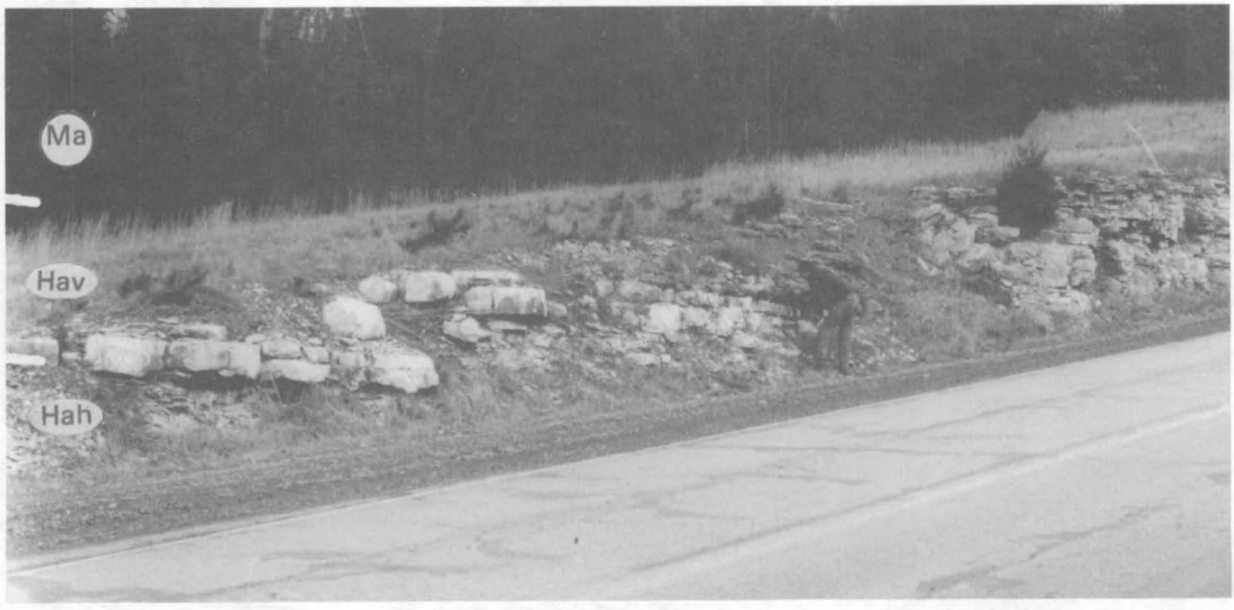


Figure 102. **Hely** *and* **Victory Members of the Hager Limestone**. **(A)** *The northeast wall of the Lone Star Industries, Inc. quarry, adjacent to the type section of the* **Hely Member of the Hager Limestone**, *Cape Girardeau County, Missouri, showing the* ***Hely*** *and* ***Victory Members of the Hager Limestone*** *(fig. 101).* **(B) Victory Member of the Hager Limestone** *in a roadcut on U.S. Highway 61, west of Ste. Genevieve (fig. 103), Ste. Genevieve County, Missouri.* **(Bl)** *Bloomsdale Limestone;* **(Ha)** *Hager Limestone;* **(Hah)** *Hely Member and* **(Hav)** *Victory Member of the Hager Limestone;* **(Ma)** *Macy Limestone. Photographs by T.L. Thompson.*

1963	**Templeton and Willman**	**Hely Member of Grand Detour Formation**
1978	Willman and Kolata	Forreston Member of Grand Detour Formation (part)
1982	Thompson	Plattin Limestone (middle part)
1986	**McCart**	**Hely Member of Hager Formation**
1988	Thompson and Spreng	Hely Member of Hager Limestone
1991	**Thompson (present report)**	**Hely Member of Hager Limestone**
		Plattin Limestone (middle part; at sections where Victory Member of Hager Limestone is absent)
1991 (in press)	**McCart and Spreng**	**Hely Member of Hager Limestone**

Remarks -- Lithologically, the Hely Member of the Hager Limestone is like that of the underlying Beckett and overlying Macy Limestones: a dark-gray, nodular-bedded burrowed mudstone, that weathers to slabby beds. This is distinctly different from the more massive, lighter gray Glaize Creek and Victory Members of the Hager. Where the Glaize Creek is poorly developed, or not present, the Hely can be difficult to distinguish from the Beckett; only the Victory Member of the Hager Limestone is identifiable, and the remainder of the section is classed as Beckett.

The interbedded nature of the Hely and Glaize Creek Members can be seen in a section on St. Charles County road F (fig. 96A), where the Hely facies is at the base, and the Glaize Creek and another Hely facies are below the thin Victory Member.

Victory Member of Hager Limestone

Templeton and Willman, 1963; Thompson, 1991 (present report)

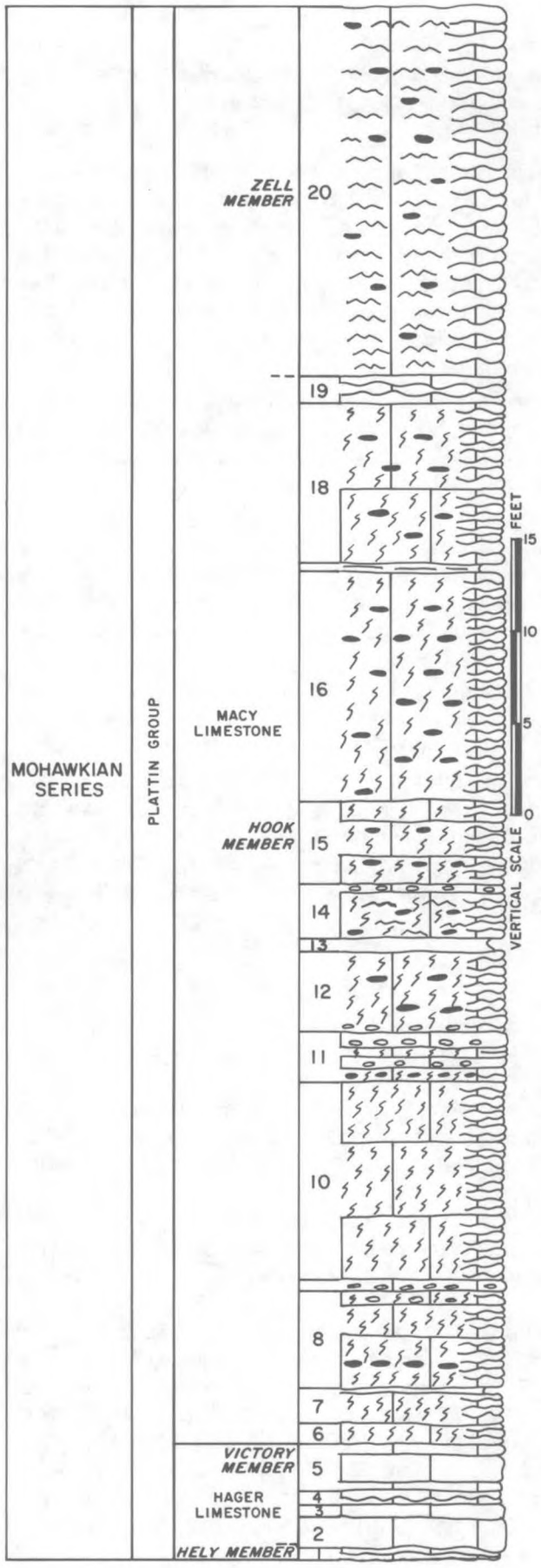
Original description -- (Templeton and Willman, 1963, p. 87) "The Victory Member is a distinctive white to light blue-gray lithographic limestone containing calcite flecks. It is relatively pure but rarely contains a few shale partings. It is massive or thick bedded. In the southern area it is partly cherty and contains *Tetradium syringoporoides* Ulrich. In the central portion of northern Illinois and southern Wisconsin it grades locally to dolomite, pure, light gray to light buff, fine to medium grained, vuggy and massive, with a smooth, white-weathered face. It is not as distinctive in the northern area as in the southern, where it is the most readily recognized member of the Platteville Group."

Type section -- Templeton and Willman (1963, p. 86) stated, "The Victory Member of the Grand Detour Formation is here named for Mt. Victory school, Calhoun County, western Illinois, which is 4½ miles north of the type section, a quarry north of West Point Landing." This quarry, 0.25 mi north of West Point Landing, in the east bluff of the Mississippi River Valley, and bluff exposures north of the quarry, are in the SE¼ NE¼ SE¼ sec. 19, T. 7 N., R. 2 W., Hardin 15' Quadrangle.

Reference sections -- The Victory Member of the Hager Limestone is prominent throughout eastern and southeastern Missouri. It is well exposed in a roadcut on U.S. Highway 61 northwest of Ste. Genevieve, Ste. Genevieve County, Missouri, center NE¼ SE¼ sec. 28, T. 38 N., R. 8 E., Weingarten 7½' Quadrangle (figs. 102B and 103). It is thin, but well developed in a roadcut on St. Charles County road F, 1.5 mi west of Defiance, SW¼ NE¼ SE¼ sec. 21, T. 45 N., R. 2 E., Defiance 7½' Quadrangle (figs. 74 and 96A), and in the roadcut on I-55 north of Pevely (figs. 69, 70A, and 91A). For other exposures of the Victory Member see "Reference sections" under **Hager Limestone** and **Plattin Group**.

History of nomenclature

1951	Larson	Hager limestone (upper part)
1961	Martin et al. (a)	Plattin formation (part)
1963	**Templeton and Willman**	**Victory Member of Grand Detour Formation**
1978	Willman and Kolata	Forreston Member of Grand Detour Formation (middle part, northern Illinois)
1986	**McCart**	**Victory Member of Hager Formation**
1988	Thompson and Spreng	Victory Member of Hager Limestone



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
PLATTIN GROUP
Macy Limestone (74 ft)
Zell Member (20 ft)

20. Limestone, gray, finely crystalline lower 2 in., lithographic above; 2-4 in. wavy beds separated by large horizontal, gray and dark-brown dolomite-filled 1-2 in. burrows; beds thicker than no. 19; scattered, nodular beds of chert; to top of cut. (20 ft)

Hook Member (54 ft)

19. Limestone, gray, finely crystalline, silty; 1-2 in. wavy beds separated by 0.25-0.5 in. brown dolomite-filled burrows; two discontinuous 1-2 in. chert beds near middle. (1 ft 6 in.)
18. Limestone, like no. 16, silty in upper half; two beds; less than 1% chert. (8 ft 6 in.)
17. Shale, brown, clayey; forms deep reentrant. (1-2 in.)
16. Limestone, gray, lithographic; thin, hackly beds; 0.25-0.5 in. burrows; lenses of unburrowed limestone; chert, less than 10%, as scattered nodules; top at shale. (13 ft)
15. Limestone, light-gray, lithographic; wavy, 1-2 in. beds with shaly partings; two nodular, discontinuous chert beds 1-2 ft apart. (4 ft 6 in.)
14. Limestone, gray, argillaceous; 0.25-0.5 in., brown, dolomite-filled, horizontal burrows; chert as scattered nodular beds; top bed lenticular, pebble conglomerate and calcarenite. (3 ft)
13. Shale, red-brown, clayey; forms deep reentrant ("metabentonite" of Larson, 1951, p. 2059). (6-10 in.)
12. Limestone, gray; hackly, wavy beds; 0.25-0.5 in. burrows; several discontinuous beds of 1-2 in. brown chert nodules; base at pebble conglomerate (no. 11), top at shale (no. 13). (4 ft 6 in.)
11. Limestone, light-gray, lithographic, to fine-grained calcarenite; even unburrowed beds separated by 6-in. burrowed zones; two pebble conglomerates, in top bed and 1 ft above base; beds change laterally from lithographic, burrowed to laminated, unburrowed, conglomeratic, calcarenites. (3 ft)
10. Limestone, like no. 8; no chert; very hackly, thin beds incipient on thick beds; 0.5-1 in. brown, dolomite-filled burrows. (10 ft 10 in.)
9. Limestone, dark-gray, finely crystalline; single bed; pebble conglomerate. (4-6 in.)
8. Limestone, gray, thick 3-ft bed, 6- and 8-in. beds; 0.25-0.5 in. burrows; white chert 1.5 ft above base; pebble conglomerate 6-in. above base. (5 ft)
7. Limestone, gray; 0.25-0.5 in. burrows; 0.5-2 in. hackly beds; top at 0.5-1 in. shale parting. (1 ft 6 in.)
6. Limestone, gray, lithographic; fossiliferous; very hackly 1-2 in. beds; 0.25-0.5 in. burrows; single bed. (1 ft)

Hager Limestone (8 ft)
Victory Member (5 ft)

5. Limestone, like no. 2; 4-6 in. beds, with 1 ft 2 in. bed at top, 8 in. bed at base. (2 ft 4 in.)
4. Limestone, light-gray, lithographic, thin-bedded. (8 in.)
3. Limestone, light-gray, lithographic; lower part brecciated. (8 in.)
2. Limestone, white to light-gray, lithographic; algal, uneven base. (1 ft 4 in.)

Hely Member (3 ft)

1. Limestone, light-gray, lithographic to fine-grained, laminated

Figure 103. **Victory Member of the Hager Limestone**, *and overlying* **Macy Limestone** *in a roadcut on U.S. Highway 61, west of Ste. Genvieve (fig.102B), center NE¼ SE¼ sec. 28, T. 38 N., R. 8 E., Ste. Genevieve County, southeastern Missouri, Weingarten 7½' Quadrangle (**type section of the Macy Limestone**). Description by T.L. Thompson, 1987.*

1991	**Thompson (present report)**	**Victory Member of Hager Limestone**
1991(in press)	McCart and Spreng	Victory Member of Hager Limestone

Remarks -- The **Victory Member of the Hager Limestone** is a light gray to nearly white, even bedded, unburrowed mudstone to very fine grainstone, less than 1 ft to nearly 7 ft thick. On fresh exposures the Victory is a prominent white unit often composed of only one or two even beds that, with the similar appearing Glaize Creek Member, stand out from the rest of the Plattin. McCart (1986) noticed that the upper few inches of the Victory usually contain "fenestral structures," a network of vertical spar-filled tubes (*Tetradium* of Templeton and Willman). He determined that these structures, concentrated at the top of the unit, are usually corroded and truncated and thereby indicate some erosion of the Victory before deposition of the overlying Plattin (Macy Limestone) resumed.

Because it is unburrowed, the Victory Member weathers to conspicuous, thick, massive ledges, usually white, which, along with the underlying Glaize Creek Member, are readily distinguishable from the pitted slabby limestone beds above and below. As in the often lithologically similar underlying Glaize Creek, chert, as individual nodules, occasionally occurs in the thicker exposures of the Victory.

Larson (1951) identified the unit now called Victory as the upper part of his **Hager Formation**, a unit primarily composed of "calcilutite." Where more than one member of the Hager is identifiable, it comprises two unburrowed, light-gray mudstone to grainstone units (the upper the **Victory Member**, and the lower the **Glaize Creek Member**), usually separated by a thinner, highly burrowed to nodular bedded zone (**Hely Member**, figs. 95A and 96). Elsewhere, the Hager Limestone comprises only the Victory Member.

The Victory, which is persistent in east-central to southeastern Missouri, usually occurs one-half to two-thirds from the top of the Establishment Member to the top of the Plattin Group (fig. 104). The discontinuous presence of the underlying Glaize Creek Member, a unit that is usually very similar to the Victory, creates the idea of a variable Victory; however, it is the Glaize Creek that is variable, not the Victory.

In Missouri, the Victory Member of the Hager Limestone is the most persistent, regionally identifiable marker bed in the thick (90-400 ft), essentially uniform, succession of limestones of the Plattin Group above the Bloomsdale Limestone (Establishment Shale and Brickeys Members). Identification of the Victory provides three prominent markers that can be used to define the position of exposures in the Plattin: shales and fossiliferous limestones of the Decorah Group at the top, **Victory** in the "middle," and **Establishment-Brickeys** at the base.

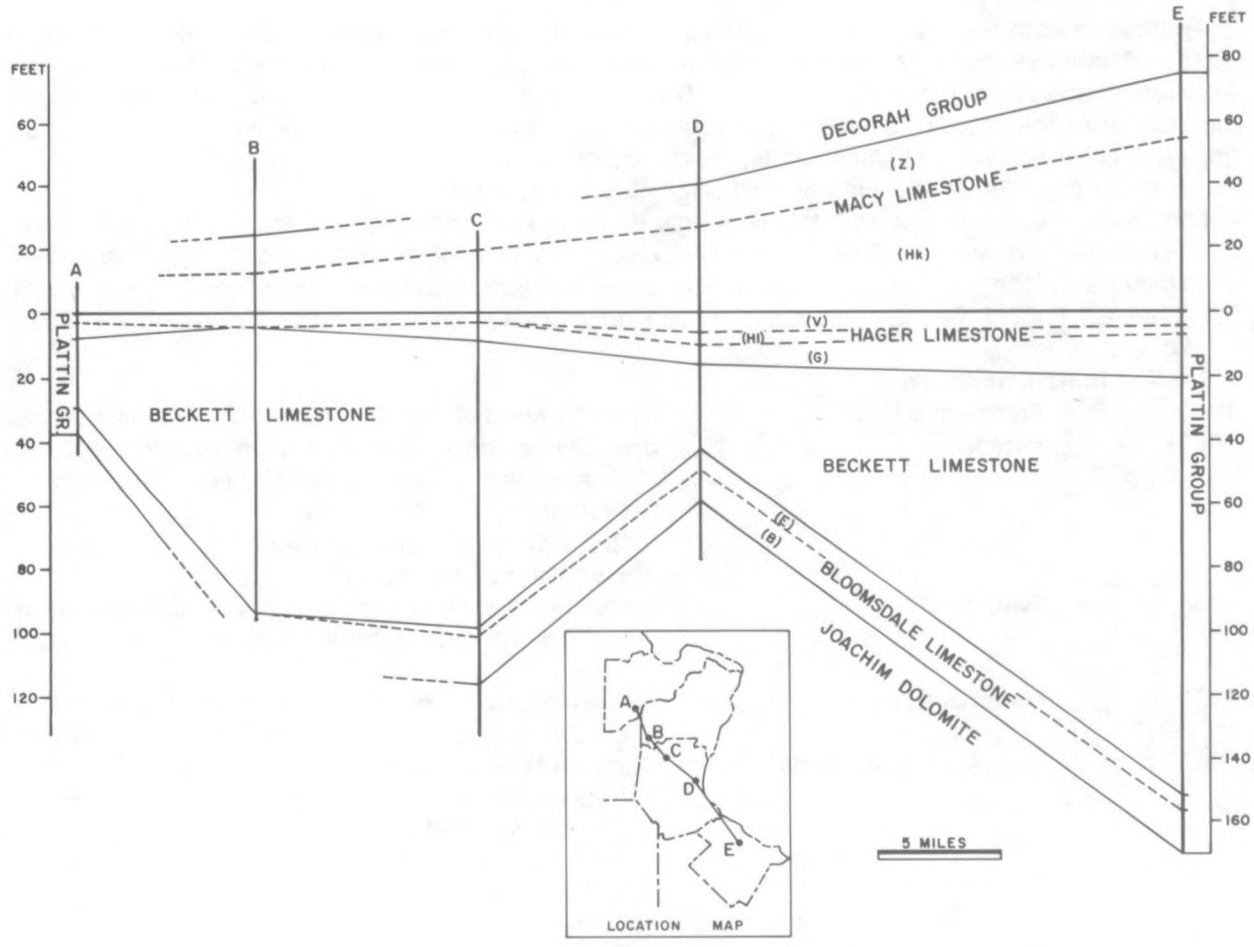
Macy Limestone

Larson, 1951

Original description -- (Larson, 1951, p. 2058) "The name Macy is applied to a formation of fine-textured calcite limestone between the underlying Hager and the succeeding Decorah formations. The Hook member of fucoidal fine calcitite, the lower part of the formation, is overlain by the Zell member of slabby fine-textured calcitite with green shale partings..."

"The Macy formation lacks the calcilutite of the Hager and is characterized by the irregular dolomitic partings of the Hook member and the green shale partings of the Zell, which is abundantly fossiliferous; the overlying Decorah formation generally includes a green shale member at the base."

Type section -- Larson (1951, p. 2058) stated, "The name Macy is from the town in Sec. 30 (proj.), T. 38 N., R. 9 E., Ste. Genevieve County. The type exposure is 3 miles west along Missouri Highway 25 [now U.S. Highway 61] in the SE.¼, NW.¼, Sec. 27, T. 38 N., R. 8 E., where the formation is 87 feet, mostly of fucoidal calcitite." The section was mislocated by Larson, and is in the SE¼ NE¼ SE¼ sec. 28, T. 38 N., R. 8 E., Ste. Genevieve County, southeastern Missouri, Weingarten 7½' Quadrangle (figs. 86, 103, 105, and 106A), about 0.5 mi south of the reference section for the Establishment Shale Member of the Bloomsdale Limestone (fig. 81A). Although the section described on figure 103 does not show the overlying Decorah Group, Dennis R. Kolata (personal communication, 1987) has re-exposed the basal Decorah strata, including the Deicke K-bentonite Bed, at the top of this locality.



(Z)	Zell Member	(G)	Glaize Creek Member
(Hk)	Hook Member	(E)	Establishment Shale Member
(V)	Victory Member	(B)	Brickeys Member
(Hl)	Hely Member		

A. Defiance roadcut, St. Charles County road F, SW¼ NE¼ SE¼ sec. 21, T. 45 N., R. 2 E., (fig. 74).
B. Six-Flags; roadcuts on I-44, center NW¼ sec. 4, T. 43 N., R. 3 E., to SW¼ SW¼SE¼ sec 33, T. 44 N., R. 3 E., St. Louis County, Missouri (fig. 72).
C. Weber Hill; roadcut on Missouri Highway 30, NE¼ sec. 27, T. 43 N., R. 4 E., Jefferson County, Missouri (fig. 68).
D. Pevely North; roadcuts on I-55, 0.5 mi north of bridge over Joachim Creek, W½ NW¼ sec. 19, T. 41 N., R. 6 E., Jefferson County, Missouri (fig. 69).
E. Zell; outcrops in creek bottom and roadcut on U.S. Highway 61, W½ sec. 34, to center NE¼ SE¼ sec. 28, T. 38 N., R. 8 E., Ste. Genevieve County, Missouri (fig. 87).

Figure 104. *Diagrammatic cross-section of formations of the Plattin Group from St. Charles to Ste. Genevieve counties, eastern Missouri, showing position of the* **Hager Limestone** *within the Group.*

Reference sections -- Several exposures in east-central and southeastern Missouri that include the Victory Member of the Hager Limestone (listed under "Reference sections" for the **Plattin Group**), are excellent exposures of the Macy Limestone. Those that include both the Victory Member of the Hager Limestone and the base of the overlying Decorah Group include **1)** the roadcut on I-44, at the Allenton-Six flags exit, SW¼ SE¼ and center south line SW¼ sec. 33, T. 44 N., R. 3 E., St. Louis County, Eureka 7½' Quadrangle (fig. 72); **2)** roadcuts on I-55 beginning 0.5 mi north of the bridge over Joachim Creek, Jefferson County, Herculaneum 7½' Quadrangle (figs. 69, 70A, and 91A); and **3)** roadcuts on St. Louis County road W, 1 mi south of Eureka, NW¼ NW¼ NE¼ sec. 12, T. 43 N., R. 3 W, Pacific 7½' Quadrangle. Both members of the Macy Limestone are also exposed in roadcuts on Missouri Highway 30 at Weber Hill, NE¼ sec. 27, T. 43 N., R. 4 E., Jefferson County, House Springs 7½' Quadrangle (fig. 68).

History of nomenclature

1946	Agnew and Hoyl	Quimbys Mill member of Platteville formation limestone
1951	**Larson**	**Macy limestone** (all but uppermost bed; included Castlewood Limestone Member of Spechts Ferry Formation, Decorah Group) **Zell limestone member** (all but uppermost bed) **Hook limestone member**
1954	Twenhofel et al.	Macy limestone (all but uppermost bed; include Castlewood Limestone Member of Spechts Ferry Formation)
1961	Martin et al. (a)	Plattin formation (upper part; included Castlewood Limestone Member of Spechts Ferry Formation)
1963	Templeton and Willman	Quimbys Mill Formation Strawbridge Member Shullsburg Member Hazel Green Member Nachusa Formation Everett Member Elm Member Eldena Member Grand Detour Formation (upper part) Forreston Member (only)
1978	Willman and Kolata	Quimbys Mill Formation Strawbridge Member Shullsburg Member Hazel Green Member Nachusa Formation Everett Member Elm Member Eldena Member Grand Detour Formation (upper part) Forreston Member (upper part)
1982	Thompson	Plattin Limestone (upper part)
1986	**McCart**	**Macy Formation**
1991	**Thompson (present report)**	**Macy Limestone** **Zell Member** **Hook Member** **Plattin Limestone (upper part; where Victory Member cannot be identified)**

Remarks -- Originally proposed for all Plattin above the Victory Member and below the green shale at the base of the Decorah, the Macy Limestone now includes all Plattin above the Victory Member of the Hager Limestone, and below the Deicke K-bentonite Bed and Castlewood Limestone Member of the

Figure 105. *Type section of the* **Macy Limestone** *of the Plattin Group, roadcut on U.S. Highway 61, center NE¼ SE¼ sec. 28, T. 38 N., R. 8 E., Ste. Genevieve County, Missouri (figs 86, 102B, 103, and 106A). Photograph by T.L. Thompson.*

Spechts Ferry Formation (Decorah Group). The Castlewood was included in the Macy when the latter was proposed by Larson.

Lithologically, lower Macy strata (Hook Member) are nearly identical to those of the Beckett Limestone. Some sections may be slightly more argillaceous, but this is not generally observed in newer roadcuts.

Larson (1951) divided the Macy at the type section into two members, the difference between them based on thin green shale partings in the upper (**Zell Member**) that are absent in the lower (**Hook Member**). At the type section (figs. 86, 103, 105, and 106A) the distinction between the **Hook Member** and **Zell Member** is obvious. The former (fig. 103, beds 6-18) comprises "typical Plattin" burrowed calcareous mudstone; the latter (fig. 103, beds 19 and 20), separated from the Hook by a very sharp contact, is wavy bedded mudstone interbedded with thin shales; the burrows are much larger than those in the Hook and indicate a strong orientation toward the horizontal. Another prominent break in the section that serves as type for both members and the formation itself, a prominent K-bentonite bed, is in the Hook Member and does not serve as a boundary. The Hook and Zell Members of the Macy Limestone have been identified at most of the exposures in east-central Missouri (fig. 106B), and are herein recognized as valid units in the Plattin Group.

The Macy Limestone, the uppermost formation of the Plattin Group, can be identified everywhere except in northeastern Missouri, north of St. Charles County, where the Victory Member is absent. In this region, **Plattin Limestone** designates the sequence identified by four formations of the **Plattin Group** in east-central and southeastern Missouri.

Hook Member of Macy Limestone

Larson, 1951; Thompson, 1991 (present report)

Original description -- (Larson, 1951, p. 2060) "The name Hook refers to the lower member of the Macy Formation composed of yellowish brown fucoidal fine calcitite with irregular buff-weathering dolomitic partings and layers of intraformational conglomerate indicating diastems. The type exposure, along Missouri Highway 25, is 55 feet thick with a 0.6-foot bed of yellowish orange metabentonite at 27 feet and a 0.1-foot metabentonite at 46 feet. Approximately 3 per cent of the type exposure is brown nodular chert which commonly fills fucoids, suggesting secondary or diagenetic origin. A discontinuous thick silicified zone below the thick metabentonite suggests that the volcanic material was the source of silica."

Figure 106 (A)
Figure 106 (B)

Figure 106. **Hook** *and* **Zell Members of the Macy Limestone (Mah** *and* **Maz).** **(A)** *The type section, a roadcut on U.S. Highway 61 west of Ste. Genevieve, center NE¼ SE¼ sec. 28, T. 38 N., R. 8 E., Ste. Genevieve County, southeastern Missouri (figs. 86 and 103). Photograph by T.L. Thompson.* **(B)** *Roadcut on the north frontage road of I-44 west of the Six Flags interchange (fig. 72). Photograph by Myrna Rueff.*

Type section -- The type section for the Hook Member of the Macy Limestone is the same as that for the formation and the overlying Zell Member, a roadcut on U.S. Highway 61, SE¼ NE¼ SE¼ sec. 28, T. 38 N., R. 8 E., Ste. Genevieve County, Weingarten 7½' Quadrangle (figs. 105 and 106A).

Reference sections -- The Hook and Zell Members of the Macy Limestone are well exposed on I-55, in roadcuts beginning 0.5 mi north of the bridge over Joachim Creek and extending north to the intersection with Jefferson County road M at Barnhart, Herculaneum 7½' Quadrangle (fig. 69); in a roadcut on the north frontage road to I-44 west of the Allenton-Six Flags exit, western St. Louis County, Eureka 7½' Quadrangle (figs. 72 and 106B); and in a roadcut on Missouri Highway 30 at Weber Hill, NE¼ sec. 27, T. 43 N., R. 4 E., Jefferson County, House Springs 7½' Quadrangle (fig. 68).

History of nomenclature

1951	**Larson**	**Hook limestone member of Macy limestone**
1991	**Thompson (present report)**	**Hook Member of Macy Limestone**

Remarks -- The Hook Member of the Macy Limestone is lithologically similar to the Beckett Limestone and is "typical Plattin." It comprises light-gray to gray, burrowed nodular mudstone interbedded with thin beds of unburrowed fine to medium grainstone. Chert, as small brown nodules, is scattered throughout and is a minor part of the member. The Hook and Zell Members appear to be distinctive units in most of east-central and southeastern Missouri.

Zell Member of the Macy Limestone

Larson, 1951; Thompson, 1991 (present report)

Original description -- (Larson, 1951, p. 2061-2062) "The name Zell, from the town of Zell, Sec. 24 (proj.), T. 37 N., R. 8 E., [sec. 34, T. 38 N., R. 8 E.], Ste. Genevieve County, refers to the fine-textured, well bedded calcitite with green shale partings above the fucoidal Hook calcitite and below the Decorah formation. The type exposure, one mile north of Zell at the type exposure of the Macy formation (Loc. 18), is 32 feet of light grayish brown, gray-weathering calcitite in 0.2-0.5-foot beds with greenish shale partings, thin layers of intraformational conglomerate and shell beds. Approximately 5 per cent of the type exposure is nodular and bedded brown chert; layers which replace shell beds are clearly secondary or diagenetic. *Pionodema*--bearing green shale of the basal Decorah formation overlies the Zell in the woods on the south side of Highway 25 [Highway 61]."

Type section -- The type section of the Zell Member of the Macy Limestone is the same as that for the underlying Hook Member and the Macy Limestone itself, a roadcut on U.S. Highway 61, SE¼ NE¼ SE¼ sec. 28, T. 38 N., R. 8 E., Ste. Genevieve County, Weingarten 7½' Quadrangle (figs. 103 and 106A).

Reference sections -- The Hook and Zell Members of the Macy Limestone are well exposed on I-55, in roadcuts beginning 0.5 mi north of the bridge over Joachim Creek and extending to the intersection with Jefferson County road M at Barnhart, Herculaneum 7½' Quadrangle (fig. 69), in a roadcut on the north frontage road to I-44 west of the Allenton-Six Flags exit, western St. Louis County, Eureka 7½' Quadrangle (figs. 72 and 106B), and in a roadcut on Missouri Highway 30 at Weber Hill, NE¼ sec. 27, T. 43 N., R. 4 E., Jefferson County, House Springs 7½' Quadrangle (fig. 68).

History of nomenclature

1951	**Larson**	**Zell limestone member of Macy limestone** (all but uppermost beds; included Castlewood Limestone Member of Spechts Ferry Formation)
1991	**Thompson (present report)**	**Zell Member of Macy Limestone**

Remarks -- Larson (1951) did not separate what is now the Castlewood Limestone Member of the Spechts Ferry Formation (Decorah Group) from the Zell Member of the Macy Limestone. He stated (p. 2062),

"A 0.5-foot metabentonite 1 foot below the top of the type exposure, and approximately 3 feet below the top of the member, has been found as far north as Kings Lake (Loc. 1), and has been questionably recognized in southern Ste. Genevieve County. A 0.3-foot metabentonite in the same stratigraphic position in an 18-foot section east of the Meramec River (Loc. 4) was believed to be the base of the Decorah formation... Beds above the clay at the type section and at the Meramec River are similar to the main part of the member but are coquinal and pinkish gray. A change from typical Zell lithology to *Pionodema*-bearing green shale with interbedded brown calcitite is 2-6 feet above the metabentonite wherever the clay is found. Herbert (1949) has traced the basal metabentonite of the Decorah from its type locality in Iowa to southeast Missouri and found that it lies above the metabentonite in the Zell. The basal Decorah metabentonite has been recognized above the type Zell and at other localities, as north of Eureka (Loc. 2), Tyson (Loc. 34), and at Kings Lake (Loc. 1)."

Recent studies (Templeton and Willman, 1963; Willman and Kolata, 1978) identify the "metabentonite" discussed above as the **Deicke K-bentonite Bed** of the Castlewood Limestone Member of the Spechts Ferry Formation, defined as the base of the Decorah Group. Larson (1951), who included a lengthy list of fossils from the Zell Member, listed *Pionodema subaequata* (Conrad), a form now known to be characteristic of Decorah strata and not present in the underlying Plattin; therefore, *P. subaequata* of Larson's study was from the Castlewood Limestone Member, not from the Zell Member of the Macy Limestone, as now defined.

The Zell Member, lithologically distinct from other units of the Plattin Group (fig. 106), comprises thin, irregular to wavy, calcareous mudstone beds separated by thin gray to gray-green wavy shale beds. Burrows filled with brown to dark gray medium- to coarse-grained carbonate are mainly horizontal and thicker than those of the underlying Hook Member. The Zell does not weather to the pitted surface of "typical Plattin," but to more slabby and nodular ledges.

Decorah Group

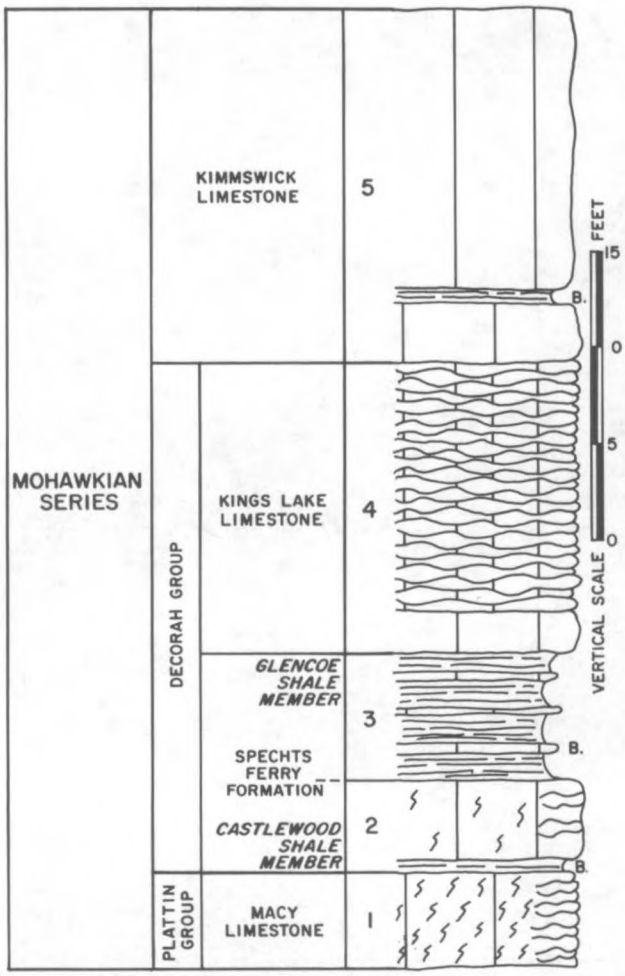
Calvin, 1906; Templeton and Willman, 1963

Original description -- (Calvin, 1906, p. 61) "The persistent body of shale between the two parts of what has generally been called the Trenton limestone, is named the Decorah shale from the city in which it is typically developed. Heretofore, it has been recognized as a distinct geological unit under the name 'Green Shales', first applied to it by the geologists of Minnesota."

Templeton and Willman (1963, p. 105) stated, "The Decorah consists largely of limestone, partly argillaceous, silty, calcarenitic, green-gray to blue-gray, lithographic to fine grained, thin bedded, with gray-green to brown-red shale partings. It locally grades to buff-weathering, argillaceous or shaly dolomite. It contains calcarenite beds, four persistent bentonite layers and traces of others, and a persistent bed of green shale. It contrasts sharply with the brown, lithographic, purer limestone of the Platteville Group below, and with the coarse-grained calcarenite or the medium-grained dolomite of the Dunleith above."

Type section -- Rocks that constitute the Decorah Group were first described in and about the city of Decorah, Winneshiek County, Iowa.

Reference sections -- Several sections are described under the three formations of the Decorah Group. Five readily accessible exposures are: **1**) a roadcut on I-55, mileage 182+, in the NW¼ sec. 6, T. 41 N., R. 6 E., Jefferson County, eastern Missouri, Herculaneum 7½' Quadrangle, (figs. 69, 107, and 108A); **2**) a roadcut on the north frontage road of I-44, west of the Allenton-Six Flags exit, sec. 33, T. 44 N., R. 3 E., western St. Louis County (figs. 72 and 108B); **3**) an exposure on St. Louis County road W, 1 mi south of Eureka, NW¼ NW¼ NE¼ sec. 12, T. 43 N., R. 3 E. , Pacific 7½' Quadrangle, (fig. 109); **4**) a roadcut on U.S. Highway 61, north of the bridge over Spencer Creek, SE¼ SE¼ sec. 21, T. 55 N., R. 4 W., Ralls County, Missouri (figs. 75 and 110A); and **5**) a roadcut on the west frontage road to U.S. Highway 61, 1.25 mi north of New London, NW¼ SW¼ NE¼ sec 36, T. 56 N., R. 5 W., Ralls County, New London 7½' Quadrangle (fig. 110B).



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Kimmswick Limestone (19 ft 6 in.)

5. Limestone, light-gray to white, coarsely crystallline; massively bedded with beds up to 5 ft thick interbedded with thin shale beds; entire unit is highly fossiliferous and burrowed; upper 11 ft appears cross-bedded on weathered surfaces; nodular white chert in lower 3 ft; prominent shale and bentonite 3 ft above base (**House Springs K-bentonite**). (19 ft 6 in.)

DECORAH GROUP

Kings Lake Limestone (15 ft)

4. Limestone, light to dark-gray, weathers to buff-gray, finely to coarsely crystalline; thin, nodular bedded, interbedded with thin green shales - lowest 2 ft is one massive bed of limestone; an alternation of highly fossiliferous, coarser crystalline beds with beds of more lithographic, non-fossiliferous limestone. (15 ft)

Spechts Ferry Formation (11 ft)

Glencoe Shale Member (7 ft)

3. Shale, green, interbedded with thin beds of limestone; shale is dominant lithology; extremely fossiliferous, with bryozoans and brachiopods; a 1-ft thick illite-montmorillonite bed occurs 1 ft above base (**Millbrig K-bentonite**). (7 ft)

Castlewood Limestone Member (4 ft)

2. Limestone, chocolate-brown, weathers to buff-gray, lithographic; massively bedded, with a thin incipient and wavy or nodular appearance; fossiliferous; a 6-in. brown clay bed occurs at base of unit. (**Deicke K-bentonite**). (4 ft)

PLATTIN GROUP

Macy Limestone (15 ft +)

1. Limestone, light-gray, sublithographic, nodular, wavy beds; some parts burrowed. (15 ft maximum)

Figure 107. *Upper part of the Plattin Group,* **Decorah Group**, *and lower part of the Kimmswick Limestone in roadcuts on I-55 between Barnhart and Pevely, Jefferson County, SW¼ NW¼ NW¼ sec 7, T. 41 N., R. 6 E., southeastern Missouri, mileage 182.5. Adapted from a description by Thacker and Satterfield (1977, p. 78).*

History of nomenclature

1895	Keyes	Trenton limestone (middle part)
1906	**Calvin**	**Decorah (in Iowa)**
1927	Dake and Bridge	Decorah formation
1928	Weller and St. Clair	Decorah shale (**restricted Plattin to present definition**)
1929	Kay (a)	Spechts Ferry formation ("Decorah" of Missouri)
	Kay (b)	"Decorah" formation ("= Spechts Ferry member of Decorah of Iowa")
1931	Kay	"Decorah" formation Housfield metabentonite
1938	McQueen and Greene	Decorah shale
1944	Branson	Upper Plattin ("so-called Decorah shale")
1948	Grohskopf	Decorah formation
1949	Herbert	Decorah formation Guttenberg Kings Lake Spechts Ferry

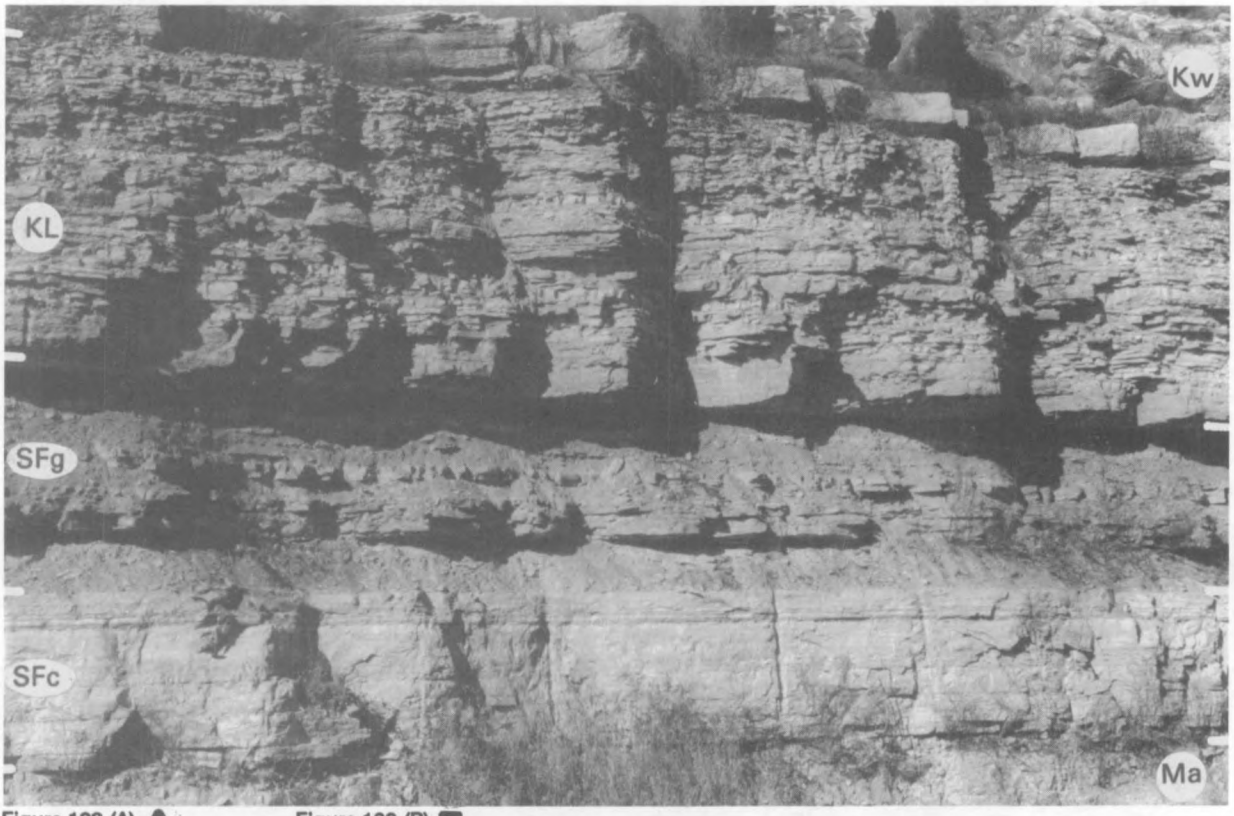


Figure 108 (A) ▲ Figure 108 (B) ▼

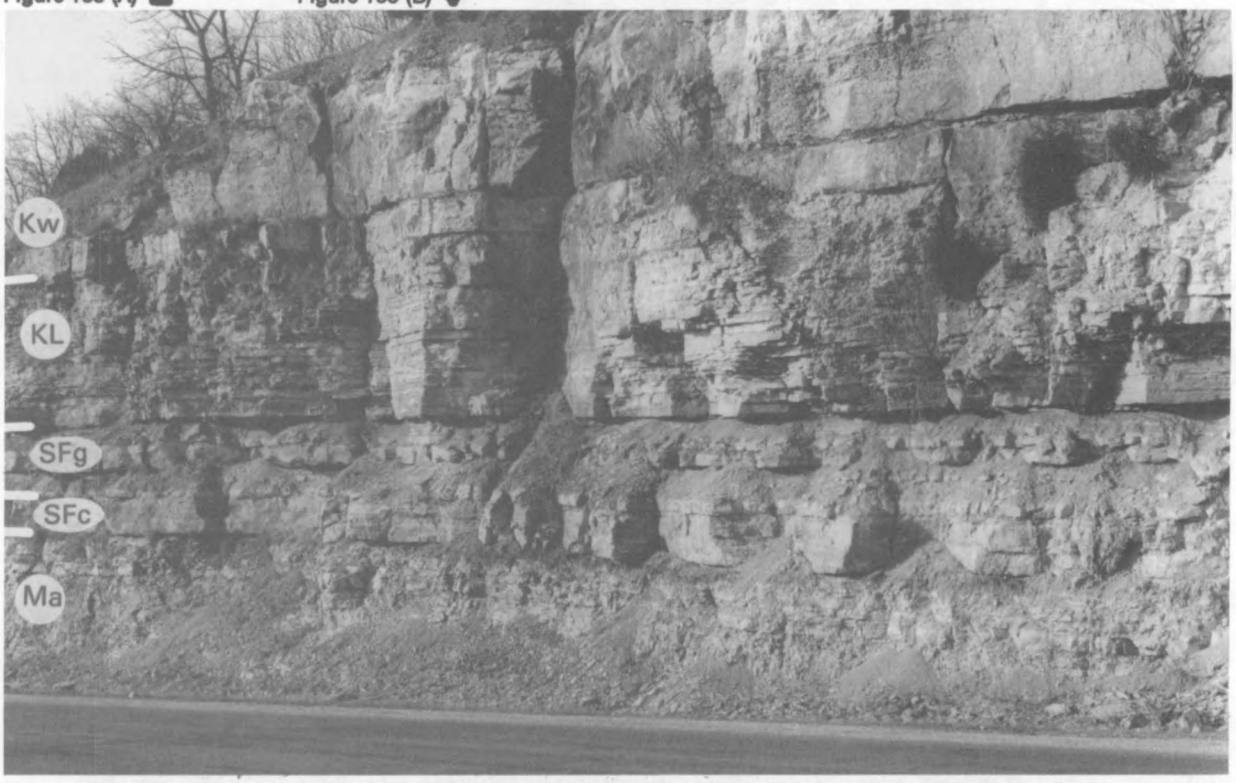
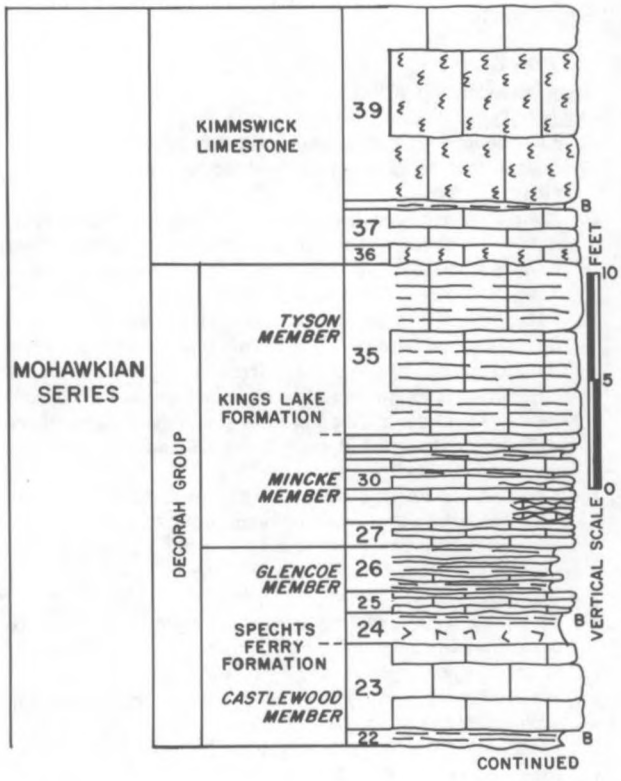


Figure 108. **Decorah Group** *in east-central Missouri.* **(A)** *Roadcut on I-55 between Barnhart and Pevely, Jefferson County, Missouri (fig. 107).* **(B)** *Roadcut on the frontage road west of the Allenton-Six Flags exit from I-44, sec. 33, T. 44 N., R. 3 E., St. Louis County, Missouri (figs. 72 and 106).* **(Ma)** *Macy Limestone, Plattin Group;* **(SFc)** *Castlewood Limestone Member and* **(SFg)** *Glencoe Shale Member of Spechts Ferry Formation;* **(KL)** *Kings Lake Limestone;* **(Kw)** *Kimmswick Limestone. Photographs by T.L. Thompson.*



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Kimmswick Limestone (13 ft +)

39. Limestone, gray, massive, medium-crystalline; lower 3 ft pitted, burrowed; top laminated. (10 ft)
38. Shale, brown, with included slabby limestone; (**House Springs K-bentonite Bed**). (3-6 in.)
37. Limestone, medium-crystalline; unburrowed; even-bedded; top at base of shale. (1 ft 6 in.)
36. Limestone, light-gray, finely crystalline; base irregular on no. 35; 0.5-0.75 in. widely spaced burrows. (1 ft)

DECORAH GROUP

Kings Lake Limestone (12 ft 8 in.)

Tyson Member (8 ft)

35. Limestone, light-bluish-gray, very finely crystalline to finely crystalline; much mudstone; irregular nodules, weathers to uneven beds; algal, fossiliferous; base blocky, hackly; large calcite crystals in upper part; 1-3 ft beds with 1-2 in. shale partings in middle; top at irregular shale parting; upper bed 1 ft 6 in to 2 ft thick, with uneven top. (8 ft)

Mincke Member (4 ft 8 in.)

34. Limestone, dark-gray; brachiopod coquina. (6 in.)
33. Limestone, lithographic; very irregular beds; on shale bed. (0-4 in.)
32. Shale, brown to green, on irregular upper surface of no. 31. (1-2 in.)
31. Limestone, light gray to bluish-gray; algal, single bed. (8 in.)
30. Limestone, gray, algal and fossiliferous; nodular beds, shaly; 0.5 in. shale at top; 2 beds. (8 in.)
29. Limestone, dark-gray, single bed; top all brachiopods; "typical" Decorah limestone. (2-3 in.)
28. Limestone, light-gray to tan, lithographic, thin, nodular 1-3 in. beds; scattered fossils. (1 ft 4 in.)
27. Limestone, dark-gray, medium-crystalline; 4-6 in. beds; fossiliferous. (1 ft 2 in.)

Spechts Ferry Formation (9 ft 6 in.)

Glencoe Shale Member (5 ft)

26. Shale and limestone; lower 6 in. green shale, followed by 1-in. limestone, 6-in. shale, 2-in. limestone, and 10-in shale with limestone nodules at top. (2 ft)
25. Limestone, dark-blue-gray; very fossiliferous; in several beds, base upward: 3-in. bed, 2-3-in. nodular bed, 2-4 in. bed, 1-in. shale, 1-2 in. bed. (1 ft 6 in.)
24. Shale, green, blocky in lower part; brown, fissile in upper part. Includes the **Millbrig K-bentonite Bed.** (1 ft 6 in.)

Castlewood Limestone Member (4 ft 6 in.)

23. Limestone, dense, sublithographic to fine-grained calcarenite; fossiliferous; two 1.5 ft beds and upper 1 ft bed. (4 ft)
22. Shale and bentonite, yellow-brown, very clayey (**Deicke K-Bentonite Bed**). (6-8 in.)

Figure 109. *Plattin Group and* **Decorah Group** *exposed in a roadcut on St. Louis County road W, 1 mi south of Eureka, NW¼ NW¼ NE¼ sec. 12, T. 43 N., R. 3 E., Pacific 7½' Quadrangle. Described by T.L. Thompson, 1986.*

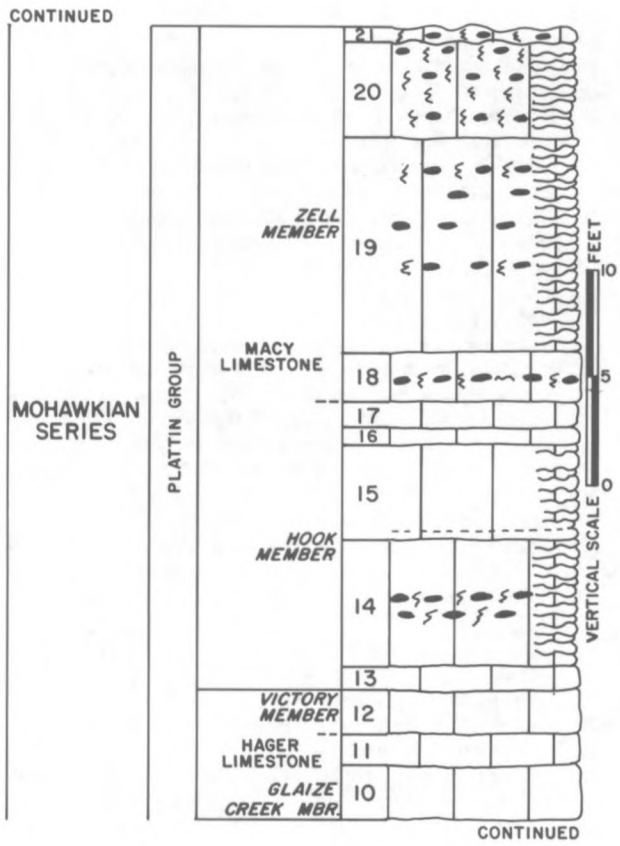


Figure 109 (cont)

PLATTIN GROUP

Macy Limestone (16 ft 6 in.)

Zell Member (7 ft)

21. Limestone, dark-gray, lithographic; very nodular beds, more nodular than no. 20; large burrows; conchoidal fracture; some chert. (1 ft 6 in.)
20. Limestone, dark-gray, lithographic, coarsely burrowed (25%); in two 2 ft beds, weathers to nodular beds; dark red-brown chert in seven discontinuous nodular beds; prominent continuous, dark gray, 2-in limestone bed at base. (4 ft)
19. Limestone, light-gray, sublithographic; dolomitic; 0.5-1 in. dolomite-filled burrows, not evident on smooth fresh face, a third to half of unit is dolomite burrow-filling, lower 8 in. with 50% brown dolomite beds; fossiliferous; some scattered dark red-brown chert in middle and upper part; single bed, weathers to slabby, nodular 1-2 in. beds (like no. 9 and no. 14); forms upper bench. (10 in)
18. Limestone, dark-gray, siliceous, silty; prominent horizontal 0.5-1 in. dark yellow-brown dolomite-filled burrows, coarser burrows than in upper part of no. 17, or in no. 15 and no. 16; scattered dark red-brown chert. (2 ft)

Hook Member (13 ft)

17. Limestone, light-gray, fine- to medium-grained, fossiliferous calcarenite to lithographic; burrowed, but not evenly; top 3 ft like no. 16; coarser burrowed lower two-thirds. (1 ft)
16. Limestone, light-gray, lithographic, more pure than no. 15; prominent vertical burrows. (8 in.)
15. Limestone, light-gray, sublithographic; even 0.25-0.5 in. burrows, like no. 14; base at continuous 2-6 in. unburrowed, laminated calcarenite; no chert. (4 ft 6 in.)
14. Limestone, light-gray, lithographic; small, even, dolomite-filled burrows; small chert nodules in middle; like no. 9; top at base of 2-6 in. laminated calcarenite bed. (6 ft)
13. Limestone, light-gray; upper half like no. 9, burrowed; lower half like no. 11, dolomitic. (1 ft 1 in.)

Hager Limestone (6 ft 4 in.)

Victory Member (2 ft)

12. Limestone, very light-gray to white, lithographic, calcilutite or mudstone; unburrowed; single bed; sharp top and base. (2 ft)

Glaize Creek Member (4 ft 4 in.)

11. Limestone, light-gray, lithographic, silty to dolomitic; unevenly burrowed; nodular chert bed at base. (1 ft 10 in.)
10. Limestone, light-gray to yellow-brown, calcarenite, dolomitic and silty, laminated; little or no burrowing; yellow-brown chert nodules in lower half, upper half chert-free; base transitional with no. 9. (2 ft 6 in.)

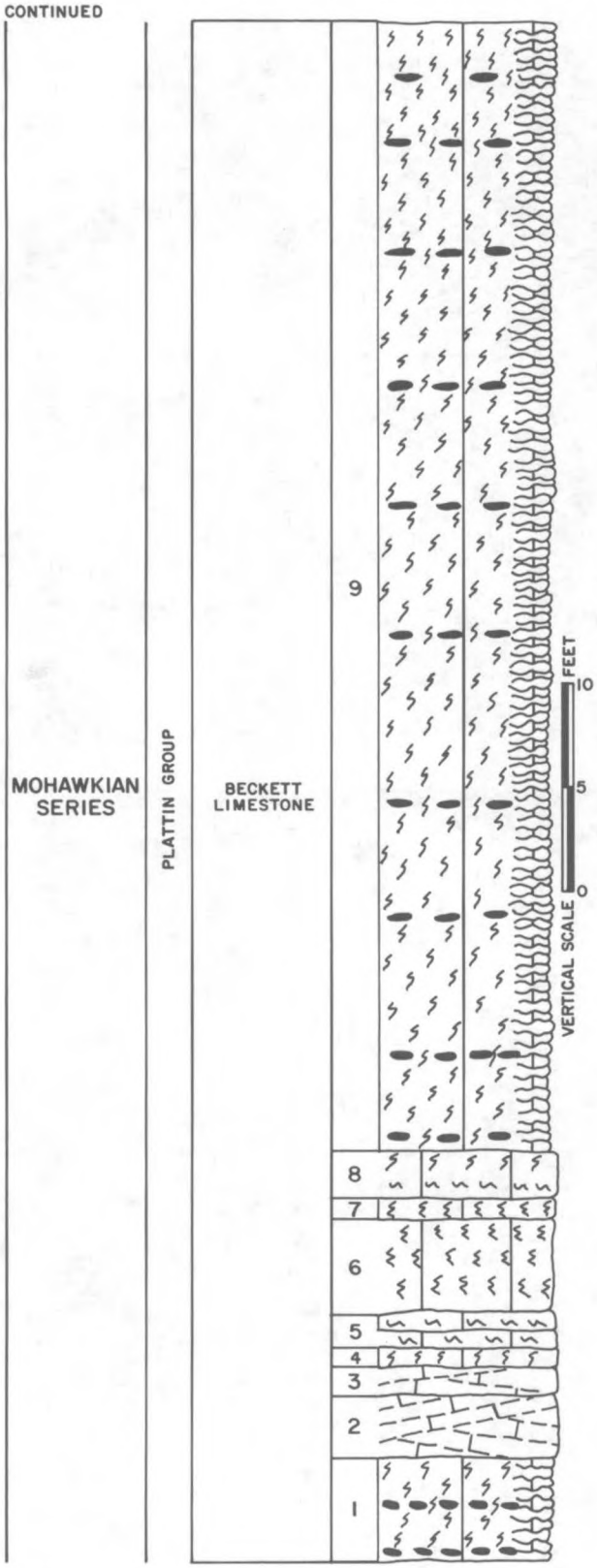


Figure 109 (cont)

Beckett Limestone (78 ft)

9. Limestone, light-gray, lithographic; small (0.25-0.5 in.), even, dolomite-filled burrows; chert, less than 10% of unit, as small scattered 1 x 4-in. brown nodules, dark red-brown chert at top; dark-gray burrow-filling with light-gray chert in middle; essentially one very thick bed. (55 ft)
8. Limestone, light-gray, lithographic; irregular, predominantly horizontal, 0.5 in burrows in lower 2 ft, burrowing differing from that in no. 6 and no. 9; contact with no. 7 sharp; some 1-2 in. continuous calcarenitic "algal" beds; contact with no. 9 weak; 4-6 in. below discontinuous chert zone. (2 ft.)
7. Limestone, light-gray; lower two-thirds lithographic, burrowed, like no. 6; upper third finely to medium-grained calcarenite, to sublithographic, burrowing not well defined; base irregular. (9 in.)
6. Limestone, light-gray, sublithographic; highly burrowed (0.5-1 in.), 35-45% dolomite burrow-filling; single bed. (4 ft 8 in.)
5. Limestone, light-gray, sublithographic, dense; uneven, predominantly horizontal, dolomite-filled burrows; fossiliferous; two beds of equal thickness. (1 ft 6 in.)
4. Limestone, light-gray, sublithographic; burrowed like no. 3, but finer crystalline; single bed. (8 in.)
3. Limestone, light-gray, fine-grained calcarenite; small (0.5 in.) dolomite-filled burrows; algal; cross-bedded, single bed. (1 ft 9 in.)
2. Limestone, light-gray, medium- to coarse-grained calcarenite; very fossiliferous, algal, or "oncolitic," cross-bedded; single dense bed. (3 ft 6 in.)
1. Limestone, light-gray, sublithographic; incipient thin (0.5-1 in.) wavy bedding; burrowed, "mottled" on fresh face, 1-2 in. tan nodular chert beds at base and middle; contact with no. 2 abrupt. (7 ft 4 in.)

Figure 110 (A) ▲ Figure 110 (B) ▼

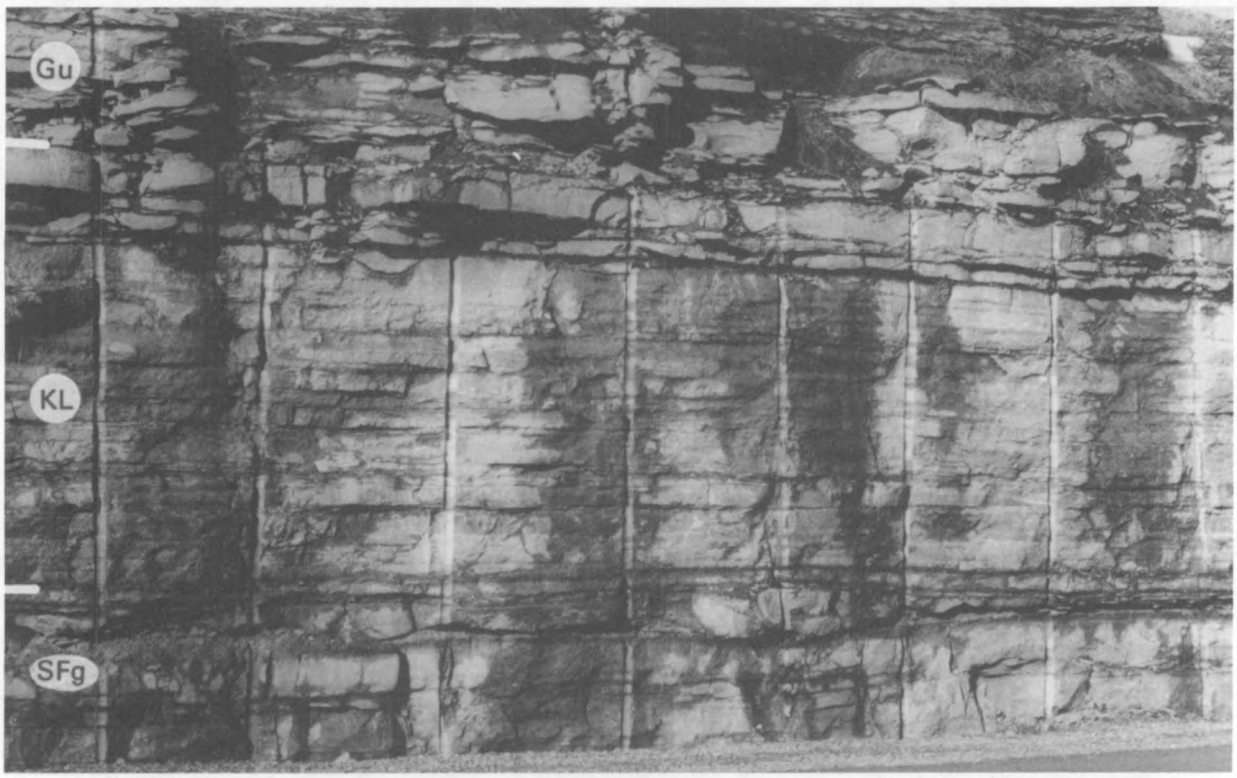


Figure 110. **Decorah Group** *in Ralls County, northeastern Missouri.* **(A)** *Roadcut on U.S. Highway 61 north of Spencer Creek, SE¼ SE¼ sec. 21, T. 55 N., R. 4 W. (fig. 75).* **(B)** *Roadcut on the west frontage road to U.S. Highway 61, 1.25 mi north of New London, NW½ SW¼ NE¼ sec 36, T. 56 N., R. 5 W.* **(Pl)** *Plattin Limestone;* **(SFc)** *Castlewood Limestone Member and* **(SFg)** *Glencoe Shale Member of Spechts Ferry Formation;* **(KL)** *Kings Lake Limestone;* **(Gu)** *Guttenberg Limestone. Photographs by T.L. Thompson.*

1951	Larson	Decorah formation Spechts Ferry member Macy limestone (upper part) Zell limestone member of Macy limestone (upper part)
1956	Cooper	Barnhart formation (replaced "Decorah" in Missouri)
1961	Martin et al. (a)	Decorah formation
1963	**Templeton and Willman**	**Decorah Subgroup of Galena Group** Guttenberg Formation Glenhaven Member Garnavillo Member Kings Lake Formation Tyson Member Mincke Member Spechts Ferry Formation Glencoe Member Castlewood Member
1966	Echols and Levin	Decorah Shale
1971	Sweet et al.	Decorah (Barnhart) Formation
1978	Willman and Kolata	Decorah Subgroup Guttenberg Formation (northern Illinois) Dickeyville Bentonite Bed Elkport Bentonite Bed Spechts Ferry Formation Glencoe Member Millbrig Bentonite Bed Castlewood Member Deicke Bentonite Bed
1982	Thompson	Decorah Formation
1986	Kolata et al.	Decorah Subgroup of Galena Group Guttenberg Formation Kings Lake Formation Spechts Ferry Formation Glencoe Member Millbrig K-bentonite Bed Castlewood Member Deicke K-bentonite Bed
1987	Thompson	Kimmswick Limestone (lower part) Decorah Formation Plattin Formation (uppermost beds)
1991	**Thompson (present report)**	**Decorah Group** **Guttenberg Limestone** **Kings Lake Limestone** **Spechts Ferry Formation** **Glencoe Shale Member** **Millbrig K-bentonite Bed** **Castlewood Limestone Member** **Deicke K-bentonite Bed**

Remarks -- Martin et al. (1961a, p. 28) described the Decorah strata in Missouri as follows:

"The Decorah consists of green or brown shales and has numerous, thin, interbedded limestone layers in its lower part that grade upward into a medium to thinly bedded, fossiliferous limestone which contains thin, fossiliferous shale partings. Beds of metabentonite lie in the basal part of the formation. The brachiopods *Pionodema subaequata* and *Rafinesquina* are the most common fossils. In the subsurface of northern Missouri, the Decorah is almost entirely a cherty dolomite or limestone with minor amounts of shale."

In Missouri the Decorah is a few feet to over 40 ft thick; it averages about 25 ft thick in eastern and southeastern Missouri. The Decorah is present throughout the subsurface in northeastern and northwestern Missouri (fig. 111), where it unconformably overlies the Plattin and, in a few places, the St. Peter Sandstone. The Kimmswick Limestone conformably overlies Decorah strata north of the vicinity of the Iowa-Missouri state line, but the two are disconformable south of this line (Kolata et al., 1986, p. 4).

The eastern and southeastern outcrop belt of the Decorah was studied in detail by Templeton and Willman (1963); much of their reclassification was based on the Missouri section. Templeton and Willman (1963, p. 101-102) indicated that prior to their study, Decorah strata exposed in eastern and southeastern Missouri had generally been regarded as equivalent to the **Spechts Ferry Member of the Platteville** of northern Illinois and northeastern Iowa. Subsequently, Herbert (1949) correlated Decorah strata in Missouri with both the Spechts Ferry and **Guttenberg** and proposed the name **"Kings Lake"** for silty limestone beds between the Spechts Ferry and Guttenberg. The Kings Lake is not present in Iowa at the type area of the Decorah.

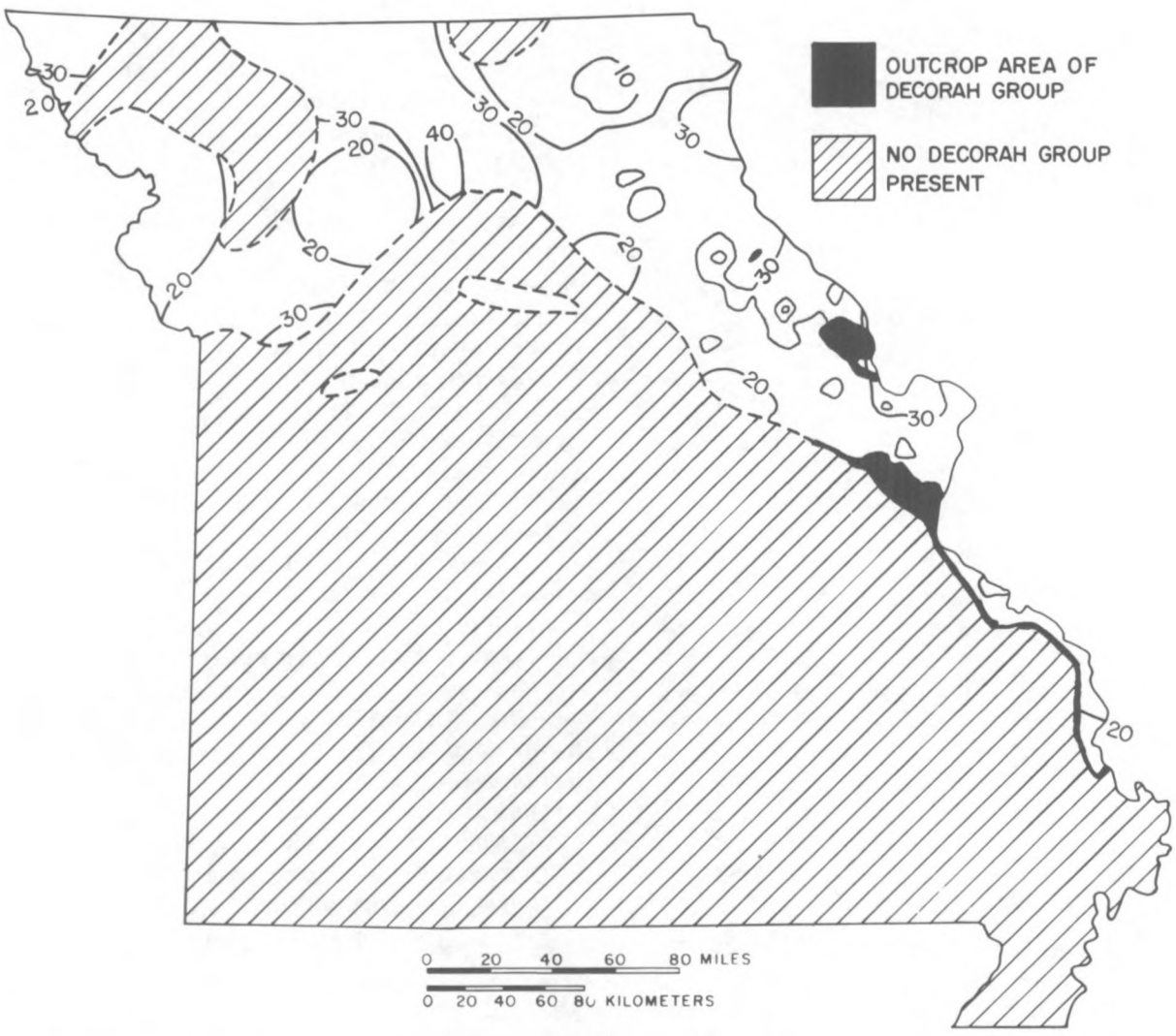


Figure 111. *Isopach map, distribution, and areas of outcrop of the* **Decorah Group** *in Missouri. Isopach interval is 10 ft.*

Cooper (1956) proposed to abandon the name "Decorah" in Missouri and proposed the **Barnhart formation** for these strata in the area south of St. Louis. In this region, the Guttenberg is absent; the Decorah comprises only Spechts Ferry and Kings Lake.

The name "Decorah" was also nearly rejected for use in Illinois until Herbert (1949) recommended its acceptance because (Templeton and Willman, 1963, p. 105):

> "(1) its usage has been long established in Illinois and Missouri, (2) the Spechts Ferry had been accepted as the basal unit of the Decorah in several recent publications, which will probably eliminate the conflict at the base of the Decorah, (3) the top boundary of the type Decorah, although commonly recognizable by close study, lacks the ease of identification desirable for a formational boundary, except in the type region, and (4) the general recognition of the Decorah as a relatively shaly unit at the base of the Galena, although time-transgressive, is consistent with recent practice and the name is appropriate because it does not require redefinition in the type region."

The upper Decorah becomes increasingly dolomitic southward from the type area. As a result, in northern Illinois, the Decorah-Galena (Decorah-Kimmswick) contact has been shifted progressively downward. The dolomite facies of upper Decorah strata was reassigned to the Galena, and the shale facies to the Decorah; as a result, until 1963, the Decorah of central Illinois and most of Missouri was defined as composed primarily of shale, with subordinant fossiliferous limestone. The overlying dolomitic limestone or limestone beds, facies of upper Decorah rocks in the type area, were identified as lower Kimmswick.

Templeton and Willman (1963) divided the Decorah interval in east-central and northeastern Missouri into three formations, each comprising two members (fig. 63). The three formations are readily identifiable; the two members of the Spechts Ferry are lithologically distinct, those of the Kings Lake are more similar, and those of the Guttenberg are difficult to distinguish. Willman and Kolata (1978) identified and named several K-bentonite beds in Decorah strata of northern Illinois. Two K-bentonites, the **Millbrig** and **Deicke K-bentonite Beds**, have been recognized in Decorah strata in Missouri. Kolata et al. (1986) defined a

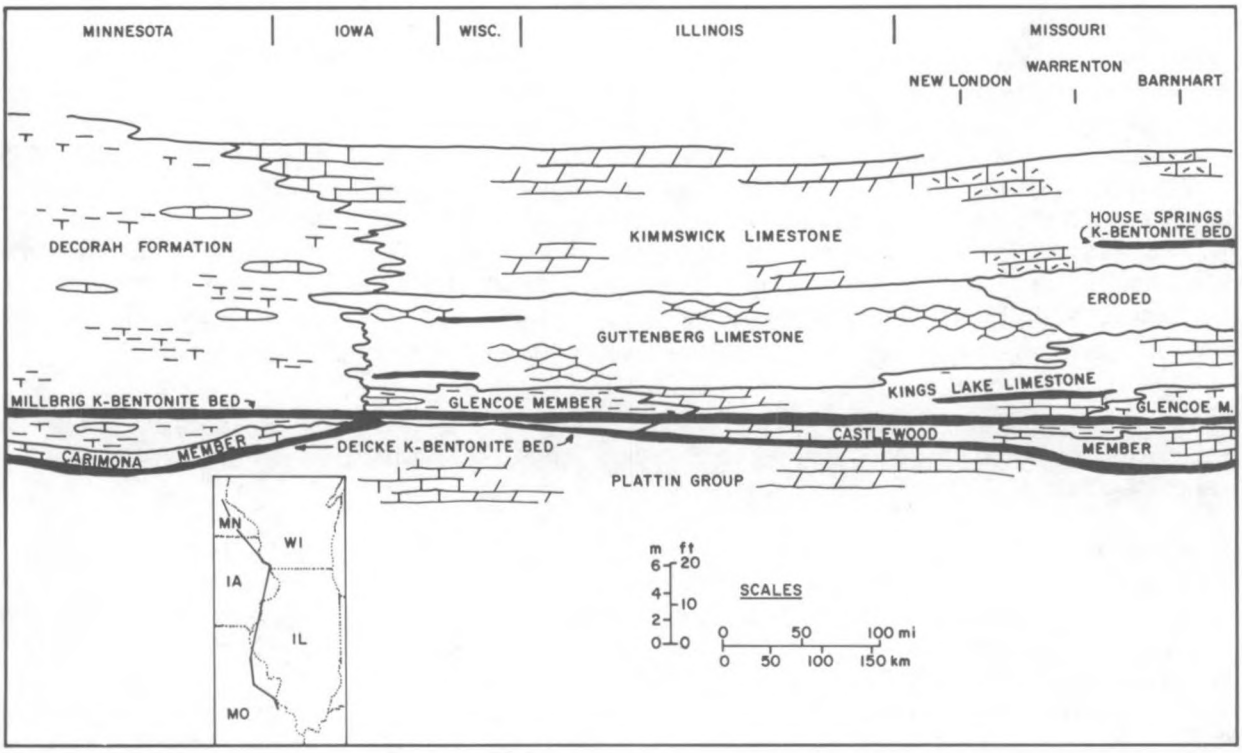


Figure 112. *Diagrammatic cross section from Minnesota to Ste. Genevieve County, Missouri, showing the relationships of the various lithologic units that constitute the* **Decorah Group**. *Adapted from Kolata et al. (1986).*

north-south facies relationship between the upper Spechts Ferry (Glencoe Shale Member), Kings Lake, and lower Guttenberg Formations (fig. 112).

Those formations and members constituting the Decorah Group in Missouri are the following:

Decorah Group
Guttenberg Limestone
Glenhaven Member
Garnavillo Member
Kings Lake Limestone
*Tyson Member
*Mincke Member
Spechts Ferry Formation
***Glencoe Shale Member**
Millbrig K-bentonite Bed
***Castlewood Limestone Member**
***Deicke K-bentonite Bed**

(* indicates units named in Missouri; those listed in **bold** are considered herein to be significant units in Missouri)

South of Lincoln County, Missouri, the upper formation, the Guttenberg, is not present; the Kimmswick lies on the upper member of the Kings Lake Limestone (fig. 112). It is important to recognize that **the dominant lithology of the Decorah in Missouri is limestone, not shale.**

Fossils are very abundant in limestones of the Decorah Group; they include the brachiopods *Sowerbyella punctostriata* (Mather) and *Rafinesquina trentonensis* (Conrad) in the Guttenberg, and *Pionodema subaequata* (Conrad) and *Doleroides gibbosus* (Billings)in the Spechts Ferry.

Spechts Ferry Formation

Kay, 1929b, 1935

Original description -- (Kay, 1935, p. 287) "The Spechts Ferry shale...was defined [Kay, 1928] as including 'the glass rock and overlying shale at the top of the typical Platteville,' but was redefined [Kay, 1931] to exclude the glass rock, which was found to be older than the base of the 8' 6" of shales with intercalated thin limestones in the type section of the member. The ten-inch beds of limestone containing pyritic and phosphatic nodules originally considered as the top of the member [Kay, 1929b] should be considered as the base of the Guttenberg member of succeeding Decorah formation.

"The dominant lithology of the member is blue-green or green, laminated claystone. In eastern Iowa, interbeds of gray, marly limestone are common in the lower part, and purplish, coarse-textured limestone and bluish, pyritic, brittle, very fossiliferous shale also are intercalated. Within a foot or so of the base is a very persistent, white clay metabentonite seam, which continues northward into Minnesota."

Type section -- Templeton and Willman (1963, p. 105-106) stated, "The type section is along a ravine just southwest of the Chicago, Milwaukee, St. Paul, and Pacific Railroad station (SW NW 4, 40N-2E, Lancaster Quad.)," Dubuque County, Iowa.

Reference sections -- Three sections located under "Reference sections" of the **Decorah Group** are excellent exposures of the Spechts Ferry Formation. A roadcut on the north frontage road of I-44 (described and illustrated under **Plattin Limestone** and **Decorah Group**; figs. 72 and 108B), west of the Allenton-Six Flags amusement park exit, is readily accessible. This section, in southern St. Louis County, is in the center SW¼ SW¼ sec. 33, T. 44 N., R. 3 E, Eureka 7½' Quadrangle.

The type section for both the Castlewood Limestone and Glencoe Shale Members of the Spechts Ferry Formation is the Mincke Section (figs. 113-115A). To visit this section, one must get permission from the gate guard and go through the Washington University Tyson Research Center, which can be reached from the Antire Road exit off of I-44.

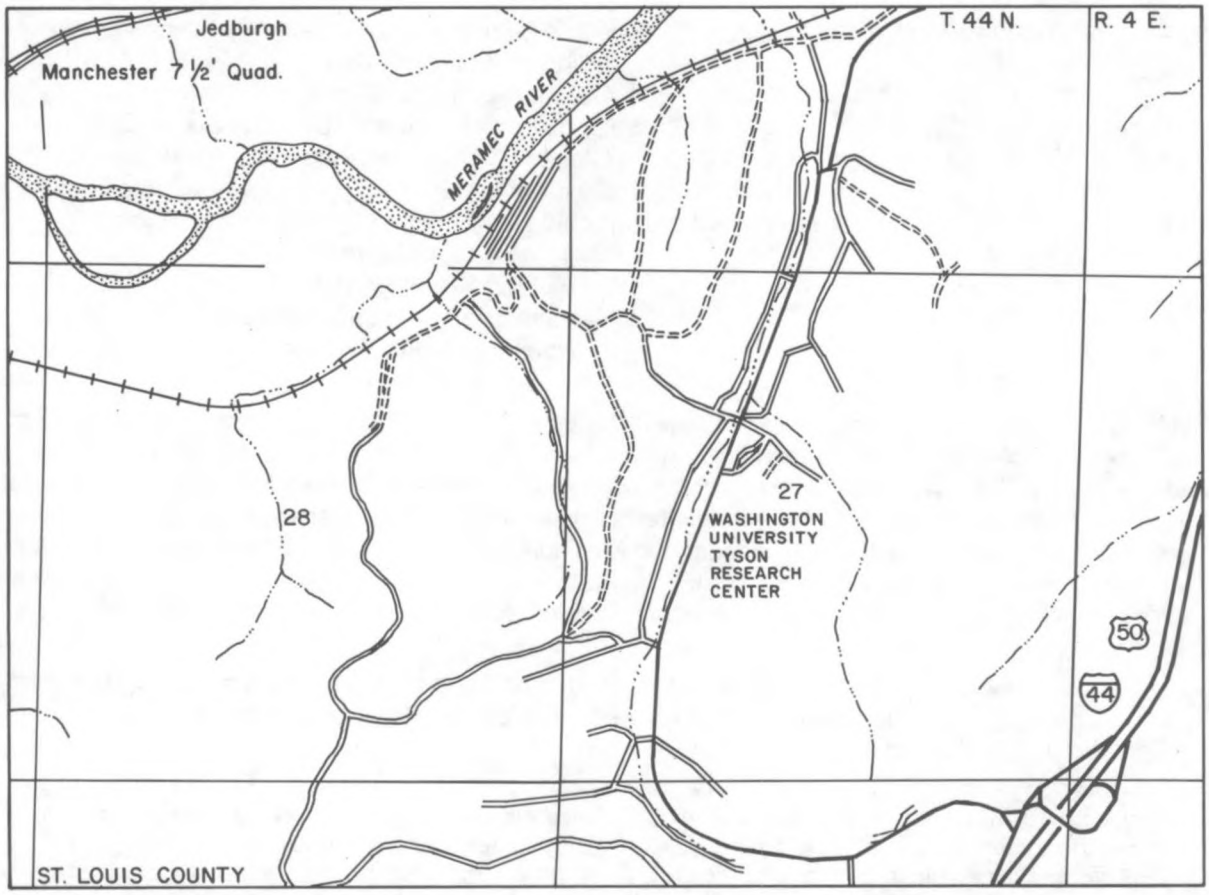


Figure 113. *Part of the Manchester 7½' Quadrangle showing the location of the type section of the* **Castlewood Limestone Member** *and* **Glencoe Shale Member of the Spechts Ferry Formation**, *Decorah Group, SE¼ SE¼ sec. 21, T. 44 N., R. 4 E., St. Louis County, east-central Missouri.*

A roadcut on the west frontage road of U.S. Highway 61, 1.25 mi north of New London, NW¼ SW¼ NE¼ sec. 36, T. 56 N., R. 5 W., Ralls County, New London 7½' Quadrangle (fig. 110B), illustrates the Spechts Ferry Formation as expressed in northeastern Missouri.

History of nomenclature

1929	**Kay (b)**	**"Decorah" formation ("= Spechts Ferry member of Decorah of Iowa")**
1948	Grohskopf	Decorah formation (lower part)
1951	Larson	Spechts Ferry member of Decorah formation Macy limestone (upper part) Zell limestone member (upper part)
1954	Kay	Spechts Ferry member of the Platteville formation
1963	**Templeton and Willman**	**Spechts Ferry Formation of Decorah Subgroup** **Glencoe Member** **Castlewood Member**
1977	Thacker and Satterfield	Decorah Formation (lower part) Plattin Formation (upper part)
1978	Willman and Kolata	Spechts Ferry Formation of Decorah Subgroup Glencoe Member (Millbrig Bentonite Bed) Castlewood Member (Deicke Bentonite Bed)

1984	Kolata et al.	Spechts Ferry Formation (Decorah Subgroup) Millbrig K-bentonite Bed Deicke K-bentonite Bed
1986	Kolata et al.	Spechts Ferry Formation (Decorah Subgroup) Glencoe Member (Millbrig K-bentonite Bed) Castlewood Member (Deicke K-bentonite Bed)
1991	**Thompson (present report)**	**Spechts Ferry Formation of Decorah Group** **Glencoe Shale Member** **Millbrig K-bentonite Bed** **Castlewood Limestone Member** **Deicke K-bentonite Bed**

Remarks -- The thin shale that marks the base of the Spechts Ferry Formation (Deicke K-bentonite Bed) lies disconformably on the Plattin Limestone. The Spechts Ferry is overlain conformably by the silty Kings Lake Limestone. The lower, massive limestone of the Spechts Ferry is identified as the **Castlewood Limestone Member**; the upper shale and interbedded thin limestone beds, as the **Glencoe Shale Member**. Maximum thickness of the formation in Missouri is about 20 ft in northeastern Scott County, southeastern Missouri (Grays Point quarry). The formation can be recognized from the northernmost outcrops near New London, Ralls County, northeastern Missouri, into northeastern Scott County, southeastern Missouri.

In Missouri, prior to 1963 (fig. 78), the Castlewood Limestone Member was included in the Plattin Limestone, and the Glencoe was identified as an undifferentiated part of the Decorah Formation. Willman and Kolata (1978, p. 42) stated,

> "**Lithology**. The Spechts Ferry is largely green calcareous shale containing thin beds of limestone, particularly in the lower part. In comparison to other shales, the Spechts Ferry is high in clay and low in silt. The limestone beds are of considerable variety -- argillaceous, nonfossiliferous, dense, fine-grained limestone; lithographic, slightly argillaceous limestone; dark purplish gray calcarenite; and coquina, the latter consisting largely of the shells of *Pionodema*...The dominantly shaly upper part of the formation, the major part, is differentiated as the Glencoe Member, which contains the Millbrig Bentonite at its base or in its lower few inches. The Castlewood Member, beneath the Glencoe Member, consists of a thin but widespread bed of limestone underlain in places by the Deicke Bentonite Bed and a thin bed of dark brown shale."

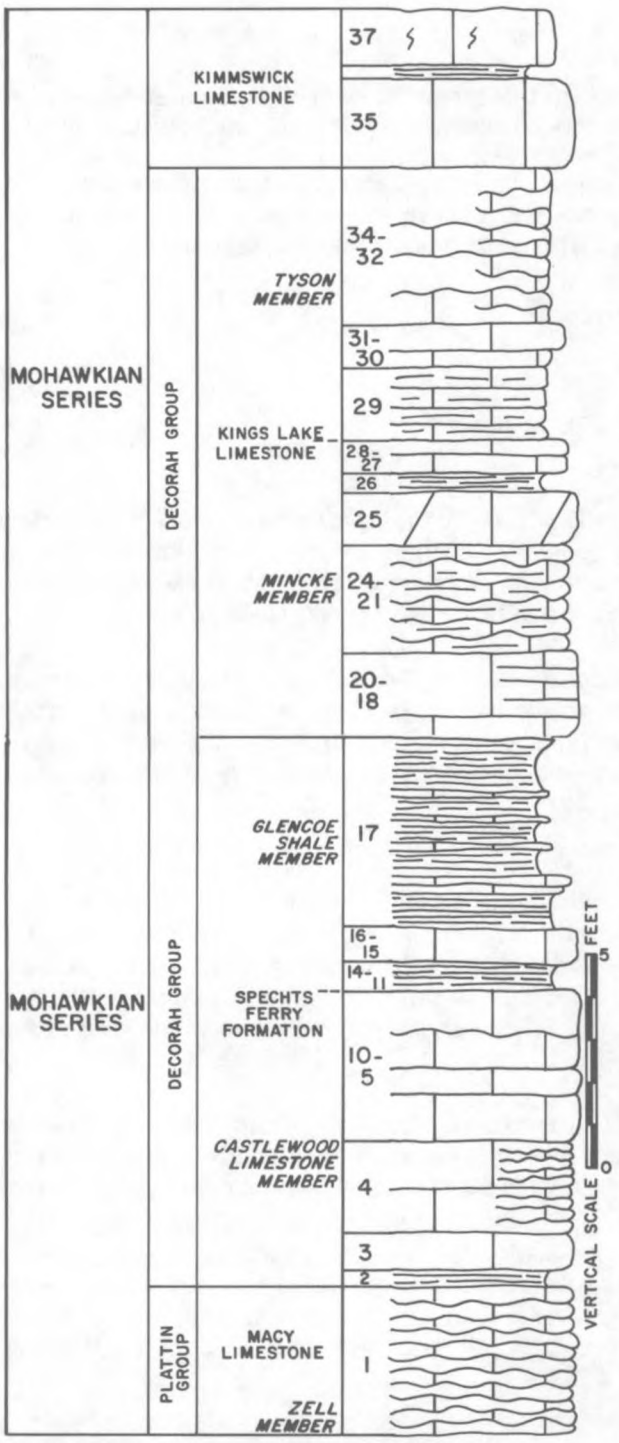
Willman and Kolata correlated the Spechts Ferry with the **Curdsville Limestone** in Kentucky and Tennessee, and with the **Selby Member of the Rockland Formation** in New York and Ontario. Rocks of the Spechts Ferry are the basal strata of the former **Trentonian Series**, which is now classified as middle **Mohawkian** (basal **Kirkfieldian**; fig. 1).

Kolata et al. (1986) restricted identification of the Castlewood Member to eastern Missouri and adjacent western Illinois; they called this unit the **Carlmona Limestone Member** of the Spechts Ferry in the northern Illinois outcrop area. Kolata et al. (1986, p. 24) stated,

> "The Castlewood has been assigned by some authors (Grohskopf, 1948; Herbert, 1949; Howe, 1961; Larson, 1951) to the Plattin Subgroup (Platteville Group) because of the lithologic similarity of the two units. Grohskopf (1948) judged that the contact between the Decorah shale and Plattin limestone (including the Castlewood) is disconformable in eastern Missouri. Zoning of the Plattin based on lithology and insoluble residues led him to believe that the Decorah (Glencoe Shale Member) overlaps older beds from the southeast to the northwest. If a disconformity exists in this area, it must lie below the Castlewood Limestone Member and the Deicke K-bentonite Bed because these units can be traced in outcrop and subsurface along a transect that for the most part coincides with that of Grohskopf (1948, p. 353, fig. 1). In this area the Glencoe Shale is conformable with the underlying Castlewood Limestone. If a disconformity does exist below the Castlewood, it would emphasize the closer relationship of the Castlewood Limestone to the Decorah rather than to the Plattin."

Kolata et al. (1984, p. 563) described the **Deicke** and **Millbrig K-bentonite Beds** in detail. They stated,

> "These are the thickest, most widespread Ordovician K-bentonites in the Mississippi Valley. The Deicke has a slightly wider distribution; it has been identified in the subsurface of northwestern Iowa and in outcrop as far south as Cape Girardeau, Missouri, a distance of about 900 km. Both beds thicken toward the southeast.



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Kimmswick Limestone (75 ft)

37. Limestone, fine- to coarse-grained calcarenite; fossiliferous, *Dalmanella* abundant, and *Sowerbyella*; massive; thick-bedded. (70 ft).
36. **House Springs K-bentonite Bed**; forms deep reentrant. (1 in.)
35. Limestone, finely crystalline; *Dalmanella* abundant; small *Receptaculites*. (3 ft 8 in.)

DECORAH GROUP

Kings Lake Limestone (12 ft)

Tyson Member (7 ft 6 in.)

34. Limestone, buff, dolomitic, very silty, argillaceous; thin to medium beds; 1 in. greenish-buff shale 7 in. below top. (2 ft 1 in.)
33. Limestone, as above, massive; calcarenitic streaks in upper 6 in. (1 ft 6 in.)
32. Shale, platy, white to orange, possibly bentonitic. (1 in.)
31. Limestone, light-gray to buff, very finely crystalline to chalky; in irregular medium beds; 2 in. bed of calcarenite with abundant *Rafinesquina* 7 in. below top; large pelecypods near base. (1 ft 4 in.)
30. Shale, buff, waxy. (1 in.)
29. Limestone, buff, argillaceous, silty; interbedded with purplish-gray, massive coquina; abundant *Pionodema* and *Zygospira*. (2 ft 5 in.)

Mincke Member (5 ft)

28. Limestone coquina of *Pionodema*; thin, buff shale partings at base. (11 in.)
27. Limestone, light-brown, argillaceous, dolomitic. (6 in.)
26. K-bentonite. (2 in.)
25. Limestone, light-brown to buff-green, argillaceous, dolomitic, very finely crystalline; contains black fossil debris. (1 ft)
24. Limestone, brown, lithographic, thin-bedded, argillaceous and chalky near bedding planes; calcareous at top; *Pionodema* abundant, *Zygospira*, *Calliops*. (7 in.)
23. Limestone, argillaceous, massive. (4 in.)
22. Limestone, light-brown, very finely crystalline; contains shale partings. (8 in.)
21. Shale, blue-gray to light red-brown. (1 in.)
20. Limestone, light-brown, argillaceous, very finely crystalline; massive. (6 in.)
19. Mudstone, greenish-buff. (1 in.)
18. Limestone, greenish-gray, very finely crystalline; contains beds of purplish-gray calcarenite; black phosphatic debris at base. (1 ft 5 in.)

Spechts Ferry Formation (12 ft 2 in.)

Glencoe Shale Member (5 ft 3 in.)

17. Shale, gray-green; in 2-7 in. beds separated by 1-2 in. lenses and beds of calcarenite and coquina. (3 ft 5 in.)
16. Limestone, purplish-gray, coarse-grained calcarenite; massive; argillaceous mottling. (8 in.)
15. Limestone, very argillaceous, laminated; fossiliferous. (3 in.)
14. **Millbrig K-bentonite Bed,** yellow-brown; and hard, pinkish gray, feldspathic siltstone. (2 in.)
13. K-bentonite, light gray. (3 in.)
12. Shale, green. (1 in.)
11. Mudstone, gray-green, calcareous. (5 in.)

Castlewood Limestone Member (6 ft)

10. Limestone, gray-green, argillaceous; black fossil debris. (8 in.)
9. Limestone, lithographic, dolomite-mottled, massive; 1-2 in. calcarenite 7 in. below top. (1 ft)
8. Limestone, gray, argillaceous, massive; black fossil debris. (5 in.)
7. Limestone, light-brown, pure, finely crystalline, massive; interbedded with calcarenite in lower 5 in.; thin shale parting 5 in. below top;. (10 in.)
6. Limestone, argillaceous at top and bottom. (5 in.)
5. Limestone, brown-gray, very finely crystalline; contains much dark fossil debris and thin calcarenite at base. (7 in.)
4. Limestone, light-gray, lithographic; in thin wavy beds; thin calcarenite beds in upper 8 in. and at bottom. (1 ft 8 in.)
3. Limestone, light-buff, very finely crystalline, slightly argillaceous, dolomitic, massive; carbonaceous and calcarenite streaks. (11 in.)
2. **Deicke K-bentonite Bed,** yellow-brown. (5 in.)

PLATTIN GROUP

Macy Limestone (18 ft)

Zell Member (12 ft 9 in.)

1. Limestone, light-gray, lithographic, wavy bedded. (12 ft 9 in.)

Figure 114. **Decorah Group** *exposed in a railroad cut at the Washington University Tyson Park Research Center (Mincke Section), SE¼ SE¼ sec. 21, T. 44 N., R. 4 E., St. Louis County, Missouri (fig. 113). This is the type section for all members of the Spechts Ferry and Kings Lake formations.*

"...It is possible...to trace the Deicke and Millbrig on certain geophysical logs through the subsurface of this area into central Kentucky and Tennessee where they correlate with the 'Pencil Cave' (T3) and 'Mud Cave' (T4) K-bentonites, respectively.

"This correlation indicates an approximately equivalent age for the Spechts Ferry Formation of the Mississippi Valley and the upper parts of the **Tyrone** and **Carters Formations** of Kentucky and Tennessee...Accordingly [from conodont biostratigraphy] these formations are in part **Rocklandian** in age [bold type mine."]

Castlewood Limestone Member of Spechts Ferry Formation

Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 109) "At the base of the member, 1 to 3 inches of black to dark brown shale is overlain by bentonite, generally less than half an inch thick but as much as 3 inches thick. In places, one or the other, or both, are absent. The bentonite is only locally present in the southern part of the northern outcrop area, but it has been observed at Bloomington, Wisconsin, and numerous places farther northwest.

"Above the bentonite the member consists of limestone that is argillaceous, partly calcarenitic, gray to brown, locally purplish, lithographic to medium grained, commonly massive, and locally contains thin beds of brown or green shale and calcarenite. Although in gross lithology this unit is similar to the Quimbys Mill below, it is more argillaceous, coarser grained, more massive, and lacks the conchoidal fracture of the 'glassy' Quimbys Mill."

Type section -- Templeton and Willman (1963, p. 107) stated, "The Castlewood Member is here named for the village of Castlewood, St. Louis County, Missouri, 1½ miles northeast of the type section, which is in the Mincke section." This section is an exposure in the south bluff of the Meramec River, along the Burlington-Northern Railroad, ¼ mi northeast of Mincke Siding, near the center of E½ SE¼ SE¼ sec. 21, T. 44 N., R. 4 E., Manchester 7½' Quadrangle (figs. 113-115). It also serves as type section for the Glencoe Shale Member of the Spechts Ferry Formation and the Mincke and Tyson Members of the Kings Lake Limestone.

Reference sections -- The sections located and illustrated under **Decorah Group** and **Spechts Ferry Formation** are excellent representatives of the Castlewood Limestone Member of the Spechts Ferry Formation. They include: **1**) a roadcut on I-55, mileage 182, in the NW¼ SW¼ NW¼ sec. 6, T. 41 N., R. 6 E., Jefferson County, eastern Missouri, Herculaneum 7½' Quadrangle (figs. 69, 107, and 108A); **2**) a roadcut on the north frontage road of I-44, west of the Allenton-Six Flags exit, sec. 33, T. 44 N., R. 3 E., western St. Louis County (figs. 72 and 108B); **3**) an exposure on St. Louis County road W, 1 mi south of Eureka, NW¼ NW¼ NE¼ sec. 12, T. 43 N., R. 3 E., Pacific 7½' Quadrangle (fig. 109); and **4**) a roadcut on U.S. Highway 61 north of the bridge over Spencer Creek, SE¼ SE¼ sec. 21, T. 55 N., R. 4 W., Ralls County, Missouri (figs. 75 and 110A).

History of nomenclature

1951	Larson	Macy limestone (upper part) Zell limestone member (upper part)
1961	Martin et al.	Plattin formation (upper part)
1963	**Templeton and Willman**	**Castlewood Member of Spechts Ferry Formation**
1977	Thacker and Satterfield	Plattin Formation (uppermost beds)
1978	Willman and Kolata	Castlewood Member of Spechts Ferry Formation **Deicke Bentonite Bed**
1984	Kolata et al.	Deicke K-bentonite Bed
1986	Kolata et al.	Castlewood Member ("= Carimona Limestone Member of Minnesota, Wisconsin, and Iowa") Deicke K-bentonite Bed

1987	Thompson	Plattin Formation (uppermost beds)
1988	Samson et al.	Diecke bentonite
1991	**Thompson (present report)**	**Castlewood Limestone Member of Spechts Ferry Formation** **Deicke K-bentonite Bed**

Remarks -- The Castlewood Limestone Member of the Spechts Ferry Formation is a thick massive mudstone to fine grainstone with incipient wavy to nodular beds, separated from the underlying Plattin Limestone by a brown and green clay shale and K-bentonite (**Deicke K-bentonite Bed**). The limestone, 6.5 ft thick at the type section, thins to around 3 ft in Jefferson and St. Louis counties (figs. 107-112A), but is a persistent, easily recognizable unit throughout the outcrop of the Decorah Group; the base of the member (and Spechts Ferry Formation) is marked by the base of the Deicke K-bentonite Bed. Kolata et al. (1986) recorded a maximum thickness of 6 m for the Castlewood Member at the Grays Point quarry in Scott County, southeastern Missouri. Willman and Kolata (1978, p. 43) described the Castlewood as follows:

> "In the type section, the member is 6 feet 11 inches thick. Where exposed north of Galena in northwestern Illinois [Jo Daviess County], it is 1 foot 6 inches thick. It is 6 inches thick in the Spechts Ferry type section and is thin and locally absent in the Wisconsin and Iowa outcrop area, but northward it thickens to 2 feet at Decorah [Iowa] and to 4 feet in southern Minnesota. The limestone is slightly argillaceous, gray, dense, very fine grained, and medium bedded to massive. It contains *Prionodema* in places but is generally unfossiliferous. The limestone commonly overlies an inch or two of green shale and a widely persistent bed of dark brown shale half an inch or less thick. The Deicke Bentonite Bed occurs either in the green shale or on top of the basal brown shale."

Willman and Kolata (1978, p. 43) named the **Deicke K-bentonite Bed** of the Castlewood Member of the Spechts Ferry Formation from the type exposure of the Castlewood Member, in St. Louis County, Missouri. They stated,

> "The Deicke Bentonite Bed, which occurs near or at the base of the Castlewood Member, is named herein for Deicke, in St. Louis County, Missouri, which is 2 miles southwest of the type section. The type section is part of the Castlewood type section in the Mincke Section (T and W, 1963, geol. sec. 25), where the bentonite is 5 inches thick. It is 3 inches thick in the Kings Lake Section near Foley in Lincoln County, Missouri, just across the Mississippi River from Calhoun County, Illinois (T and W, 1963, geol. sec. 26). The Deicke Bentonite Bed is present in many localities in the Upper Mississippi Valley outcrop region but is less continuous than the Millbrig Bentonite Bed above the Castlewood. It is commonly a light gray, plastic clay as much as 2 inches thick...The bentonite has not been found in the few exposures of the Castlewood Member in northwestern Illinois, but it probably is present elsewhere in the subsurface in that area, as well as in Calhoun County, Illinois. It is correlated with the prominent bentonite at the base of the Curdsville in Kentucky and Tennessee."

Kolata et al. (1986, p. 18) described this K-bentonite in detail, and stated that it is commonly 5 to 7 cm thick, but varies from less than 5 cm in western Illinois to 15 cm near Ste. Genevieve, to a maximum of 40 cm near Cape Girardeau. They correlated the Deicke K-bentonite as possibly equivalent to the **"Pencil Cave"** or **T-3** K-bentonite of Kentucky and Tennessee.

Glencoe Shale Member of Spechts Ferry Formation

Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 110) "Near the base of the Glencoe is the most persistent Ordovician bentonite in the Mississippi Valley. It commonly is from 1 to 3 inches thick, locally 8 inches thick, and occurs in a 1- to 2-foot zone of interbedded green, gray, or brown shale with thin beds of fine-grained limestone, coquina, or calcarenite. In places the bentonite occurs in the shale and in other places it has limestone both above and below..."

"Above the bentonite, but in places separated from it by 2 to 6 inches of gray or green shale, is a persistent bed of limestone. The limestone is brown, locally gray, fossiliferous, fine-grained, argillaceous, and commonly 1 to 3 feet thick. In the southern outcrop area the limestone more commonly is a dark purplish gray coquina of *Pionodema* and is about a foot thick.

"The upper two-thirds or more of the member consists largely of green shale, but in some areas the lower part is gray or brownish gray. It contains beds, locally as thick as 1 foot, of greenish gray argillaceous limestone, calcarenite, coquina, and dark gray coarse-grained limestone."

Type section -- The Glencoe Member of the Spechts Ferry Formation was named from the village of Glencoe, St. Louis County, Missouri. The type section (3 mi east of Glencoe), the Mincke section, is an exposure in the south bluff of the Meramec River, along the Burlington-Northern Railroad, 0.25 mi northeast of Mincke Siding, near the center of the E½ SE¼ SE¼ sec. 21, T. 44 N., R. 4 E., Manchester 7½' Quadrangle (figs. 113-115). This section is also the type section for the Castlewood Limestone Member of the Spechts Ferry Formation and the Mincke and Tyson Members of the Kings Lake Limestone.

Reference sections -- The sections located under **Decorah Group** and **Spechts Ferry Formation** are representative of the Glencoe Shale Member of the Spechts Ferry in Missouri. These include: **1)** a roadcut on I-55, mileage 182, in the NW¼ SW¼ NW¼ sec. 6, T. 41 N., R. 6 E., Jefferson County, eastern Missouri, Herculaneum 7½' Quadrangle (figs. 69, 107, and 108A); **2)** a roadcut on the north frontage road of I-44, west of the Allenton-Six Flags exit, sec. 33, T. 44 N., R. 3 E., western St. Louis County (figs. 72 and 108B); **3)** an exposure on St. Louis County road W, 1 mi south of Eureka, NW¼ NW¼ NE¼ sec. 12, T. 43 N., R. 3 E., St. Louis County, Pacific 7½' Quadrangle (fig. 109); and **4)** a roadcut on U.S. Highway 61 north of the bridge over Spencer Creek, SE¼ SE¼ sec. 21, T. 55 N., R. 4 W., Ralls County, Missouri (figs. 75 and 110A).

History of nomenclature

1948	Grohskopf	Decorah formation (lower part)
1961	Martin et al. (a)	Decorah formation (lower part)
1963	**Templeton and Willman**	**Glencoe Member of Spechts Ferry Formation**
1977	Thacker and Satterfield	Decorah Formation (basal part)
1978	Willman and Kolata	Glencoe Member of Spechts Ferry Formation **Millbrig Bentonite Bed**
1984	Kolata et al.	Millbrig K-bentonite Bed
1986	Kolata et al.	Glencoe Member of Spechts Ferry Formation Millbrig K-bentonite Bed ("= Housfield metabentonite of Chaumont Formation, New York")
1988	Samson et al.	Millbrig bentonite
1991	**Thompson (present report)**	**Glencoe Shale Member of Spechts Ferry Formation** **Millbrig K-bentonite Bed**

Remarks -- The Glencoe Shale Member of the Spechts Ferry Formation comprises green to brown clay shale with interbedded thin, even beds of dark gray to purple, very fossiliferous to coquinoidal limestone. Approximately 5.5 ft thick at the type section, the Glencoe Member is a persistent marker within the Decorah Group. The shale is readily discernible from the prominent limestones of the Plattin Limestone and Castlewood Limestone Member below, and the overlying thin-bedded, slabby, silty limestone of the Kings Lake Limestone. In many older reports, the prominent shale of the Glencoe was regarded as the basal unit, sometimes the only unit, of the Decorah Formation; the thick limestone of the underlying Castlewood Member was identified as Plattin (Larson, 1951; Thacker and Satterfield, 1977).

Willman and Kolata (1978, p. 43) stated,

> "The Glencoe is 5 feet 3 inches thick in the type section. In northern Illinois, the Glencoe is exposed along the Galena River north of Galena, where it is 1 foot 6 inches thick. It is largely green shale with thin beds of limestone, and it contains *Pionodema* in great abundance. The Millbrig Bentonite Bed occurs at the base of the Glencoe."

Willman and Kolata (1978, p. 59) named the **Millbrig Bentonite Bed** of the Glencoe Member of the Spechts Ferry Formation from a section in Jo Daviess County, northern Illinois, the type section being in a

> "Cutbank along east side of Galena River, 1 mi southeast of Millbrig, Jo Daviess Co., IL (near center 34, 29N-1E Galena Quad.)"

Figure 115. *Type section of the* **Castlewood Limestone Member** *and* **Glencoe Shale Member of the Spechts Ferry Formation**, *St. Louis County, Missouri (figs. 113 and 114).* **(A)** *The succession from the top of the Macy Limestone (upper Plattin Group) to the Kimmswick Limestone.* **(B)** *The Castlewood Limestone Member, overlying Glencoe Shale Member, and the Deicke K-Bentonite Bed beneath.* **(Ma)** *Macy Limestone;* **(*)** *Deicke K-bentonite Bed;* **(SFc)** *Castlewood Limestone Member and* **(SFg)** *Glencoe Shale Member of Spechts Ferry Formation;* **(KL)** *Kings Lake Limestone;* **(Kw)** *Kimmswick Limestone. Photographs by T.L. Thompson.*

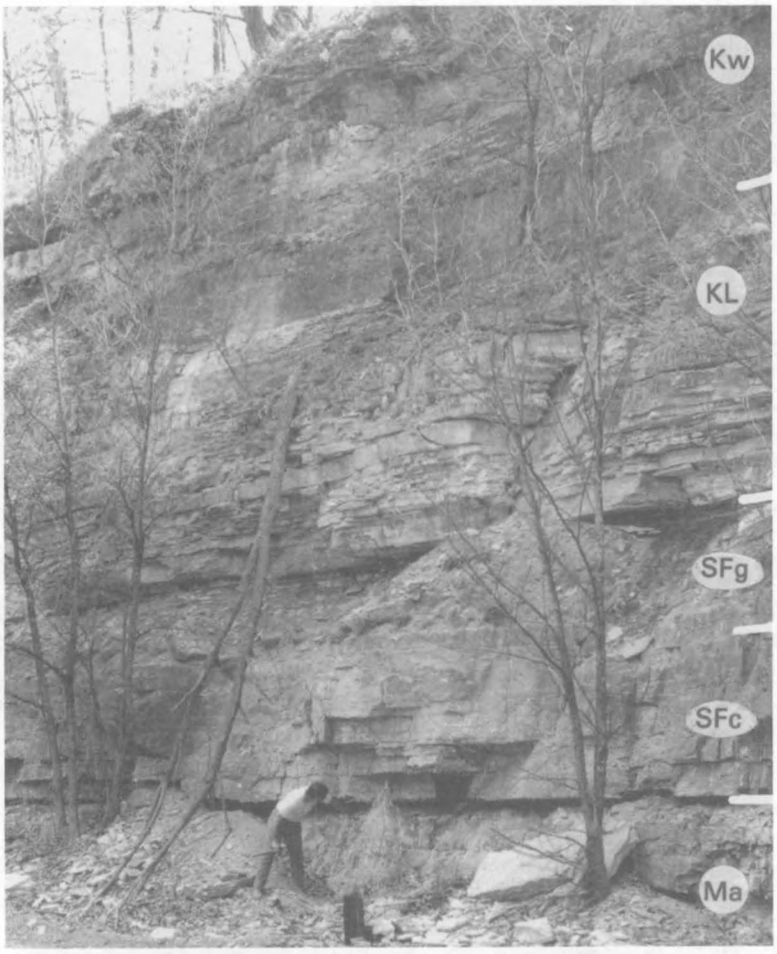
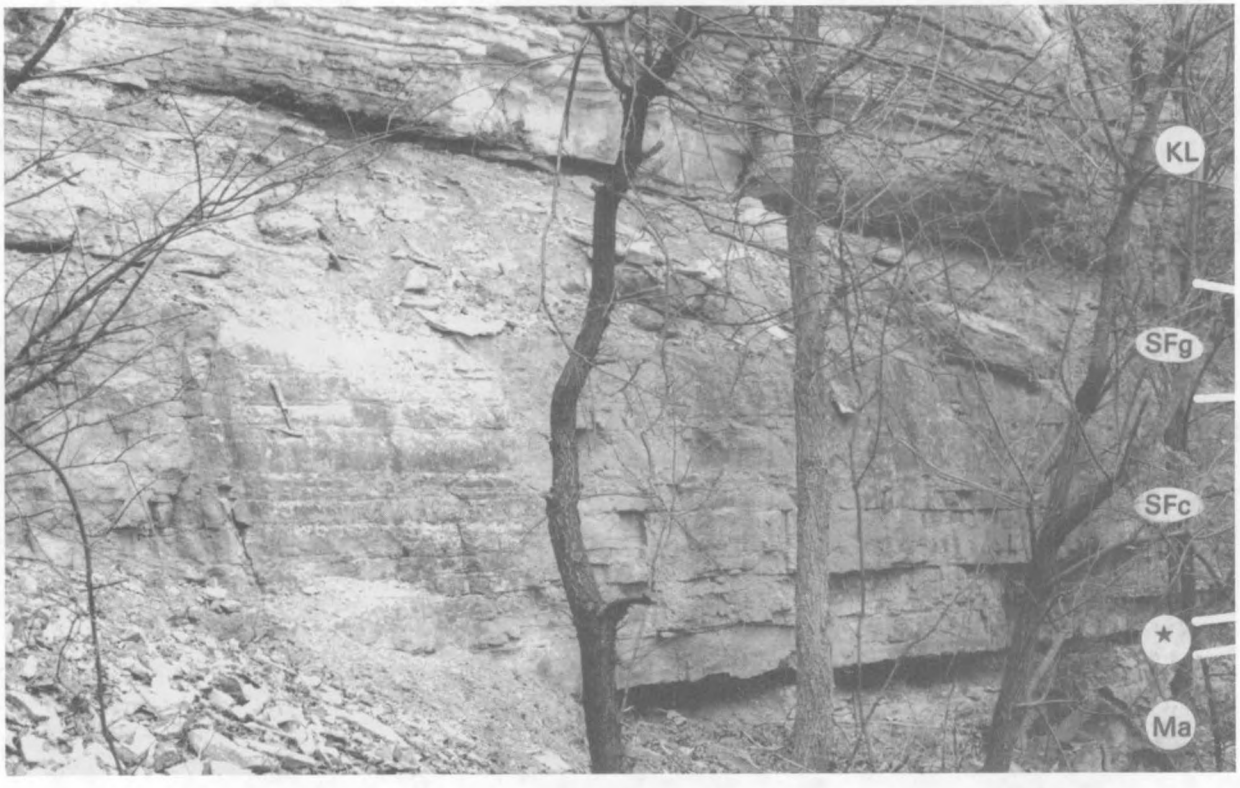


Figure 115 (A)

Figure 115 (B)



They added (p. 43),

> "The type section is in the Millbrig Southeast Section, where the bentonite is as much as 4 inches thick. In the region where the Spechts Ferry Formation is present, the Millbrig Bentonite Bed is the most consistently present and the thickest Champlainian bentonite. It is a light gray plastic clay, stained orange by limonite in many places, and its mineral composition is typical of Ordovician bentonites."

In the southern outcrop area Kolata et al. (1986) described a variation in thickness of the Millbrig K-bentonite: about 4 cm in Illinois to more than 15 cm near Ste. Genevieve, Missouri. Kolata et al. (1986) reported the Millbrig K-bentonite to be absent at Jonesburg (northwestern Warren County, east-central Missouri) and south of Bloomsdale (northern Ste. Genevieve County, southeastern Missouri). Willman and Kolata (1978) correlated the Millbrig K-bentonite with the **Housfield Bentonite** in the **Selby Member of the Rockland Formation** in New York, and with an unnamed K-bentonite at the top of the **Curdsville Limestone** in Kentucky and Tennessee (the **"Mud Cave"** or **T-4** K-bentonite of Kolata et al., 1986).

Kings Lake Limestone

Herbert, 1949; Templeton and Willman, 1963

Original description -- Originally named by Herbert (1949) in an unpublished dissertation, the first published description of the Kings Lake was by Templeton and Willman (1963, p. 110): "The Kings Lake consists largely of argillaceous, very silty, dolomitic limestone with some thin beds of shale and calcarenite. It locally contains finely sandy beds and Guttenberg-type red shale partings. In many characteristics it is transitional between the Spechts Ferry and Guttenberg, but it is more silty and sandy than either of them."

Type section -- The type section for the Kings Lake Limestone (Templeton and Willman, 1963, p. 236) is an exposure in the west bluff of the Mississippi River Valley, 1.6 mi north of Foley, Lincoln County, Missouri, about 500 ft north of the road junction at Kings Lake, in the SE¼ SE¼ NE¼ sec. 26, T. 50 N., R. 2 E., Foley 7½' Quadrangle (figs. 116-118).

Reference sections -- Because the type section for the Kings Lake Limestone is essentially inaccessible, several sections described previously are recommended for studying the characteristics of this formation. These include: **1**) a roadcut on I-55,, mileage 182, in the SW¼ NW¼ NW¼ sec. 7, T. 41 N., R. 6 E., Jefferson County, eastern Missouri, Herculaneum 7½' Quadrangle (figs. 107 and 108A); **2**) a roadcut on the north frontage road of I-44, west of the Allenton (Six-Flags) exit, sec. 33, T. 44 N., R. 3 E., western St. Louis County (figs. 72 and 108B); **3**) an exposure on St. Louis County road W, 1 mi south of Eureka, NW¼ NW¼ NE¼ sec. 12, T. 43 N., R. 3 E., Pacific 7½' Quadrangle (fig. 109); and **4**) a roadcut on U.S. Highway 61 north of the bridge over Spencer Creek, SE¼ SE¼ sec. 21, T. 55 N., R. 4 W., Ralls County, Missouri (figs. 75 and 110A).

The type section for the two members of the Kings Lake Limestone (Mincke and Tyson Members), which were named by Templeton and Willman (1963), is the Mincke Section, SE¼ SE¼ sec. 21, T. 44 N., R. 4 E., in St. Louis County (figs. 113 and 114).

History of nomenclature

1949	**Herbert**	**Kings Lake formation** (unpublished dissertation)
1961	Martin et al. (a)	Decorah formation (part)
1963	**Templeton and Willman**	**Kings Lake Formation** Tyson Member Mincke Member
1986	Kolata et al.	Kings Lake Formation
1987	Thompson	Kimmswick Limestone (lowermost beds)
1991	**Thompson (present report)**	**Kings Lake Limestone**

Remarks -- The Kings Lake Limestone is a thin- to slabby-bedded, silty and dolomitic, fossiliferous, finely crystalline to coquinoidal limestone interbedded with thin shale partings. It lies conformably on the

shale and interbedded thin limestone of the Glencoe Shale Member of the Spechts Ferry Formation. In northeastern Missouri, north of St. Charles County, it is conformably overlain by the slabby, nodular, but thicker bedded Guttenberg Limestone, but is disconformably overlain by the Kimmswick Limestone in east-central and southeastern Missouri (fig. 112). At the type section, in Lincoln County, Missouri, the Kings Lake is just over 4 ft thick; it is as much as 13 ft thick in St. Louis County, Missouri (figs. 109 and 114).

Templeton and Willman (1963) divided the Kings Lake into two members: the lower, **Mincke Member** and the upper, **Tyson Member**. The type section of both members is the same as that for the Castlewood Limestone Member and Glencoe Shale Member of the Spechts Ferry Limestone, in southern St. Louis County, Missouri (fig. 114). The lower, Mincke Member is more silty and argillaceous than the Tyson Member. In northeastern Missouri the latter (figs. 75 and 110B) is more argillaceous and silty than the overlying Guttenberg Limestone. The Tyson is more or less transitional between the Mincke and basal Guttenberg beds, but it is much thinner bedded than the latter and more like the former.

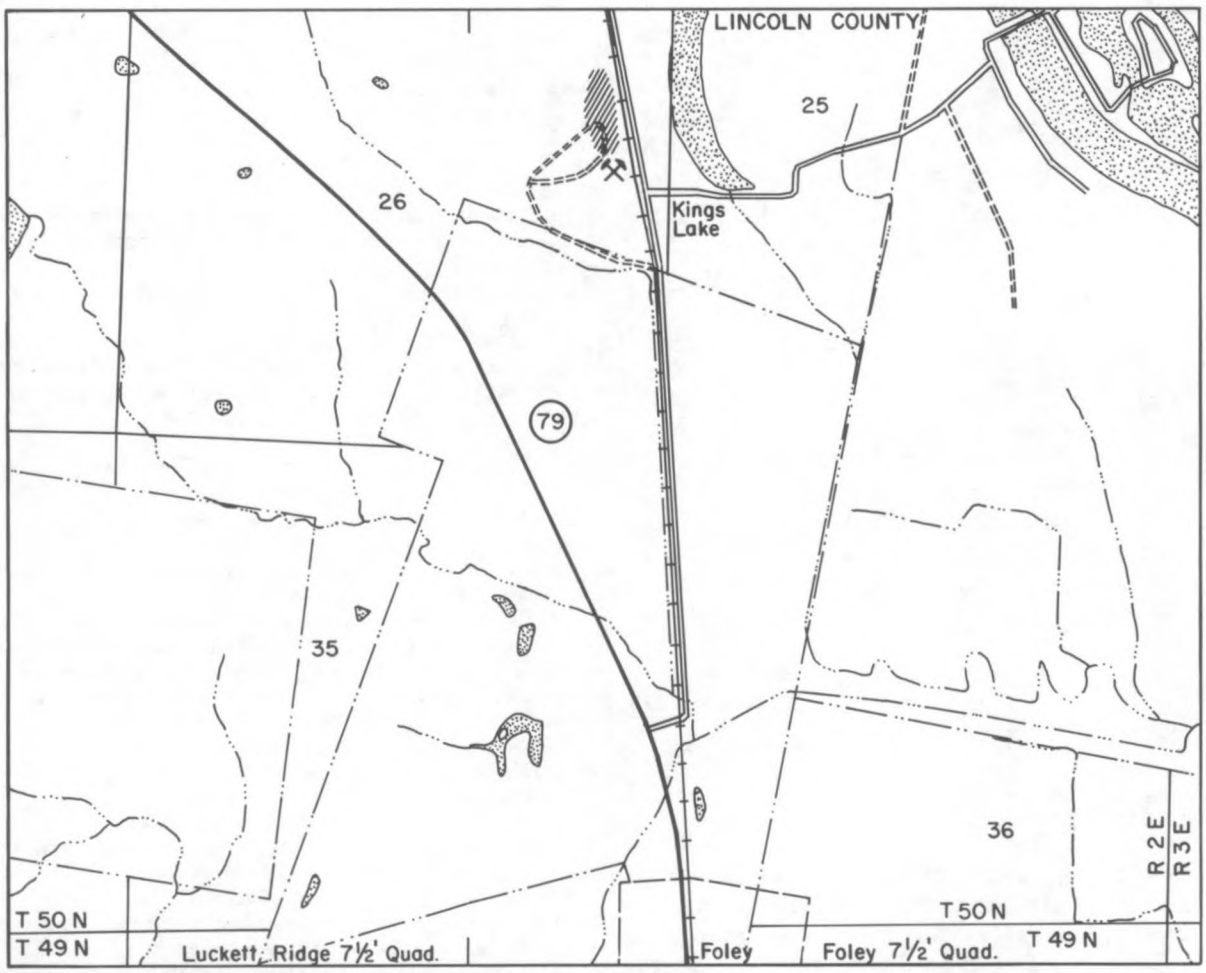


Figure 116. *Parts of the Foley and Luckett Ridge 7½' quadrangles showing location of the type section of the* **Kings Lake Limestone** *of the Decorah Group, SE¼ SE¼ NE¼ sec. 26, T. 50 N., R. 2 E., Lincoln County, eastern Missouri.*

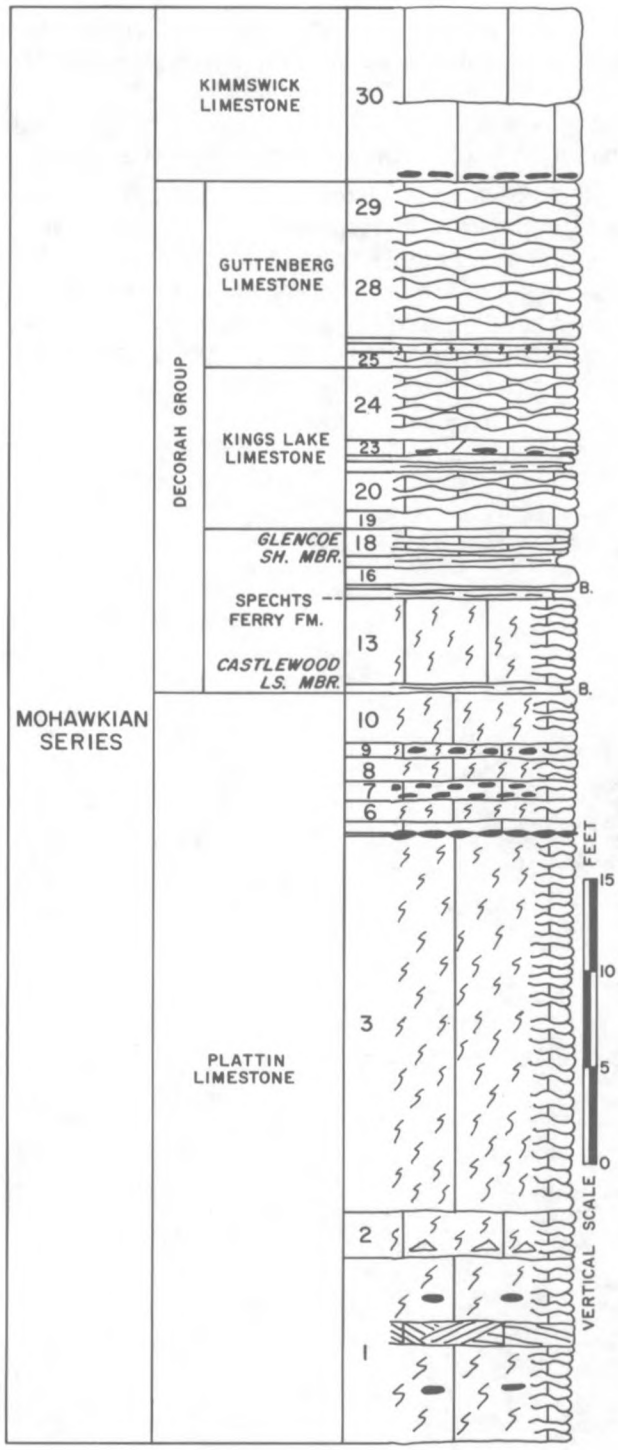


Figure 117. *Type section of the* **Kings Lake Limestone**, *Decorah Group, in a bluff on the west side of the Mississippi River Valley (fig. 116), SE¼ SE¼ NE¼ sec. 26, T. 50 N., R. 2 E., Lincoln County, Missouri. Adapted from a description by Templeton and Willman (1963, p. 236).*

ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Kimmswick Limestone (10 ft +)

30. Limestone, coarse-grained calcarenite. (10 ft)

DECORAH GROUP

Guttenberg Limestone (11 ft)

29. Limestone, light-brown, finely crystalline; in 2-4 in. wavy beds with red-brown shale partings; contains very fossiliferous beds, with a 2-4 in. coquina at base; large chert nodules in band on top of coquina, and a few nodules 7 in. higher; grayer, coarser textured and thicker bedded than below. (2 ft 5 in.)
28. Limestone, brown, very finely crystalline; in thin, wavy beds separated by red-brown shale; lower 1 ft 10 in. more massive. (6 ft 4 in.)
27. **Elkport K-bentonite Bed.** (1 in.)
26. Limestone, very finely crystalline; contains worm borings filled with red-brown shale. (6 in.)
25. Limestone, buff-gray, dolomitic, silty; in 3-6 in. even beds; contains thin layers of calcarenite. (1 ft 10 in.)

Kings Lake Limestone (10 ft)

24. Limestone, buff, dolomitic, argillaceous, silty; 1-6 in. beds of calcarenite and coquina; *Pionodema*, *Sowerbyella*, *Zygospira*, and bryozoans. (4 ft 3 in.)
23. Limestone, calcarenitic; contains thin beds of coquina and dolomitic limestone; red chert in lower 4 in. (1 ft)
22. Limestone, light-brown, argillaceous; brown shale partings; very fossiliferous. (4 in.)
21. Shale, brown; 0.5 in. bentonite 0.5 in. above base. (3 in.)
20. Limestone, light-gray; in 1-4 in. beds, interbedded with calcarenite and brown shale. (2 ft 3 in.)
19. Limestone, green-buff, silty, massive; contains a little fine sand. (1 ft 1 in.)

Spechts Ferry Formation (8 ft 7 in.)

Glencoe Shale Member (3 ft)

18. Limestone, medium-grained calcarenite; in 1-4 in. beds, interbedded with brown shale. (1 ft 11 in.)
17. Shale, green. (4 in.)
16. Limestone, brown, very coarse-grained coquina; fossil fragments in greenish-brown lithographic limestone mottled with green clay. (1 ft 1 in.)
15. Limestone, gray-brown, medium- to coarsely crystalline; fossiliferous. (6 in.)
14. **Millbrig K-bentonite Bed,** yellow-brown. (2 in.)
13. Limestone, lithographic, fucoidal, thin- to medium-bedded; lower 6 in. weathers white and has argillaceous mottling; lower 1 ft 3 in. is dolomite-mottled. (5 ft. 3 in.)

Castlewood Limestone Member (5 ft 7 in.)

12. Limestone, yellow, coarsely crystalline; phosphatic nodules. (1 in.)
11. **Deicke K-bentonite Bed,** yellow-brown. (3 in.)

Plattin Limestone (41 ft)

10. Limestone, buff, argillaceous; in medium, partly irregular beds. (2 ft 9 in.)
9. Limestone, buff, argillaceous; massive; cherty. (1 ft)
8. Limestone, buff, argillaceous; thin to medium beds. (1 ft 4 in.)
7. Limestone, very finely crystalline, slightly argillaceous, massive; smooth faced; chert band at top and at base. (1 ft)
6. Limestone, light-buff, slightly argillaceous, dolomite-mottled, massive; weathers in thin to medium beds. (1 ft)
5. Limestone, very light-gray (white bed). (9 in.)
4. Chert, prominent bed of nodules. (3 in.)
3. Limestone, gray, very finely crystalline, massive; very fucoidal (burrowed), heavily dolomite-mottled; rough weathered surface; contains several bands of chert nodules; a few thin layers of calcarenite near the base. (20 ft 8 in.)
2. Limestone, as above; medium beds; smooth-face; conglomeratic; much fossil debris. (2 ft 2 in.)
1. Limestone, as above, but interbedded with fine-grained, cross-bedded calcarenite; *Foerstephyllum* 4 ft above base; contains a little chert; base concealed. (10 ft 1 in.)

Templeton and Willman (1963) indicated the Kings Lake appears to thin and disappear northward, but is present in Kentucky, Tennessee, and Virginia. They correlated the bentonite in the Mincke Member with the **T-5 bentonite** in Tennessee.

The Kings Lake is not present in the northern outcrop region of Minnesota, Wisconsin, Iowa, and northern Illinois; in that region Guttenberg strata lie on the Spechts Ferry Formation. Kolata et al. (1986, p. 4-5) stated,

> "It [Kings Lake] thins northward to 2 m thick near New London and pinches out in the subsurface northeast of Burlington, Iowa (Herbert, 1949). The Kings Lake contains grayish green and very dusky red shale partings; thus, it appears to be transitional in lithology between the Spechts Ferry and Guttenberg Formations. It probably represents a facies of the upper part of the Glencoe Member of the Spechts Ferry and the basal part of the Guttenberg Formation."

Figure 118. *Type section of* **Kings Lake Limestone** *of the Decorah Group, SE¼ SE¼ NE¼ sec. 26, T. 50 N., R. 2 E., Lincoln County, Missouri (fig. 117).* (**Pl**) *Plattin Limestone;* (**SF**) *Spechts Ferry Formation;* (**KL**) *Kings Lake Limestone;* (**Gu**) *Guttenberg Limestone;* (**Kw**) *Kimmswick Limestone. Photograph by T.L. Thompson.*

Guttenberg Limestone

Kay, 1928, 1935; Templeton and Willman, 1963

Original description -- (Templeton and Willman, 1963, p. 112) "From Guttenberg south to the northern part of the southern outcrop area (Calhoun County, Illinois), the Guttenberg is a distinctive and remarkably uniform unit. It consists of thin-bedded, tan to gray, white-weathering, lithographic limestone interbedded with brown-red carbonaceous shale. The Guttenberg grades eastward to fine- to medium-grained dolomite in subsurface between the northern and southern outcrop areas."

Type section -- Templeton and Willman (1963, p. 112) stated, "The Guttenberg Formation was named for the town of Guttenberg, Clayton County, Iowa (Kay, 1928, p. 16). The type section is in a ravine half a mile north of town, but at present the Guttenberg is better exposed in a nearby roadcut on U.S. Highway 52..." (SW¼ SW¼ sec. 5, T. 92 N., R. 2 W.).

Reference sections -- Four exposures of the Guttenberg Limestone are exemplary of this formation in northeastern Missouri: **1**) the Kings Lake Section (described under **Kings Lake Limestone**), SE¼ SE¼ NE1/4 sec. 26, T. 50 N., R. 2 E., in Lincoln County (figs. 117 and 118); **2**) a quarry 2.0 mi north of New London, in the NE¼ NW¼ sec. 36, T. 56 N., R. 5 W., Ralls County, New London 7½' Quadrangle (figs. 119 and 120A); **3**) a roadcut on Highway 61 immediately north of the bridge over Spencer Creek, SE¼ SE¼ sec. 21, T. 55 N., R. 4 W., Ralls County, Hannibal SE 7½' Quadrangle (figs. 75 and 120B); and **4**) a small quarry off of a gravel road 1 mi north of the Pike-Lincoln county line, SE¼ SE¼ SE¼ sec. 28, T. 52 N., R. 2 W., Pike County, Eolia 7½' Quadrangle.

History of nomenclature

1928	**Kay**	**Guttenberg formation (in Iowa)**
1961	Martin et al. (a)	Decorah formation (upper part)
1963	Templeton and Willman	Guttenberg Formation of Decorah Subgroup (2 members)
1978	Willman and Kolata	Guttenberg Formation ("= upper part of Decorah Formation in eastern Missouri")
1982	Kolata and Jollie	Guttenberg Formation
1986	Kolata	Guttenberg Formation
	Kolata et al.	Guttenberg Formation
1991	**Thompson (present report)**	**Guttenberg Limestone**

Remarks -- The Guttenberg Limestone is a light gray sublithographic fossiliferous limestone, with thick, slabby, medium-thick beds (4 to 8 in.) separated by thin reddish to brown shale partings. There is a distinct change in bedding between Kings Lake and Guttenberg rocks, and the contact with the thick-bedded, coarse calcarenite of the overlying Kimmswick Limestone is very abrupt.

Guttenberg strata in Missouri are exposed in Lincoln, Pike, and Ralls counties, between the underlying Kings Lake Limestone and overlying Kimmswick Limestone. From Lincoln County southward the Guttenberg thins until it pinches out north of St. Louis County (fig. 112). Basal Guttenberg strata are conformable with the underlying Kings Lake strata and were truncated by pre-Kimmswick erosion in eastern and southeastern Missouri. The disconformable Guttenberg-Kimmswick contact is marked by rounded pieces of Guttenberg material incorporated in basal Kimmswick sediments (fig. 120).

Some limestone and shale beds are very fossiliferous; common fossils include the brachiopod genera *Dinorthis, Rafinesquina, Sowerbyella*, and *Strophomena*. Willman and Kolata (1978) report that the trilobite *Eomonorachus intermedius* (Walcott) is abundant on bedding planes in northwestern Illinois and southwestern Wisconsin.

Willman and Kolata (1978, p. 44-45) stated,

> "The Guttenberg Formation in Illinois is equivalent to the Guttenberg Member of the Decorah Formation in the Upper Mississippi Valley, except some have included the strata here called Garnavillo in the Spechts Ferry (Agnew et al., 1956). The Guttenberg is equivalent to the upper part of the Decorah Formation in

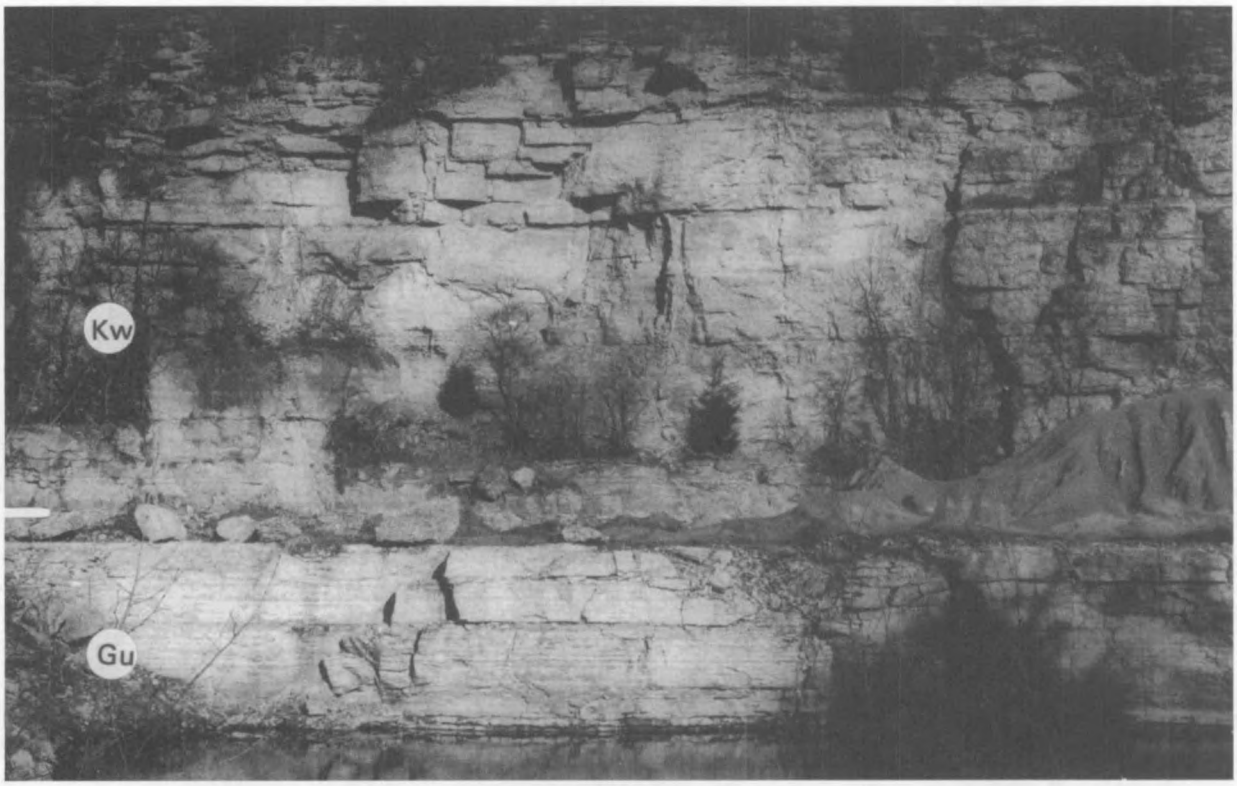


Figure 119. **Guttenberg Limestone (Gu)** *and Kimmswick Limestone* **(Kw)** *in a quarry on the west side of U.S. Highway 61, 1.5 mi north of New London, NE¼ NW¼ sec. 36, T. 56 N., R. 5 W., Ralls County, Missouri. Photograph by T.L. Thompson.*

> eastern Missouri, to part of the **Logana** in Kentucky and the **Hermitage** in Tennessee, and the **Napanee Member of the Rockland Formation** in New York and Ontario [bold type mine]."

Templeton and Willman (1963) recognized two members of the Guttenberg (fig. 63) -- the **Garnavillo** and **Glenhaven Members** -- which they described in the northern outcrop region of Ralls and Lincoln Counties, Missouri. They stated (p. 113),

> "The Garnavillo is consistently grayer, more argillaceous, thicker bedded, and contains less shale than the Glenhaven above."

In northeastern Missouri this distinction is too subtle to be of much use.

A charactertistic feature of the Guttenberg, the **red to red-brown shale beds** separating the limestone beds, serves to distinguish Guttenberg from the overlying Kimmswick and underlying Kings Lake Limestones. However, presence of similar "dusky red" shales in upper Kings Lake beds in eastern Missouri led Kolata et al. (1986, p. 5) to conclude that the Kings Lake Formation

> "...probably represents a facies of the upper part of the Glencoe Member of the Spechts Ferry and the basal part of the Guttenberg Formation."

Willman and Kolata (1978, p. 45) named the **Elkport K-bentonite Bed** as the basal unit of the Glenhaven Member of the Guttenberg Formation in northern Ilinois. The type section is the same as that for the Glenhaven Member. They stated (p. 45),

> "It [Elkport Bentonite] is as much as an inch thick. In places the bentonite occurs as several very thin layers of gray clay interbedded with dark red-brown shale, the entire unit 1 1/2 inches thick."

This unit is represented in Missouri by the 1-in. bentonite bed at the Kings Lake type section described under **Kings Lake Limestone** (fig. 117, unit 27: **Elkport K-bentonite Bed**). Another bentonite bed, approximately 3 ft below the top of the Glenhaven Member in northern Illinois, was named the **Dickeyville Bentonite Bed** by Willman and Kolata (1978, p. 45), who did not determine if it was also present in Missouri.

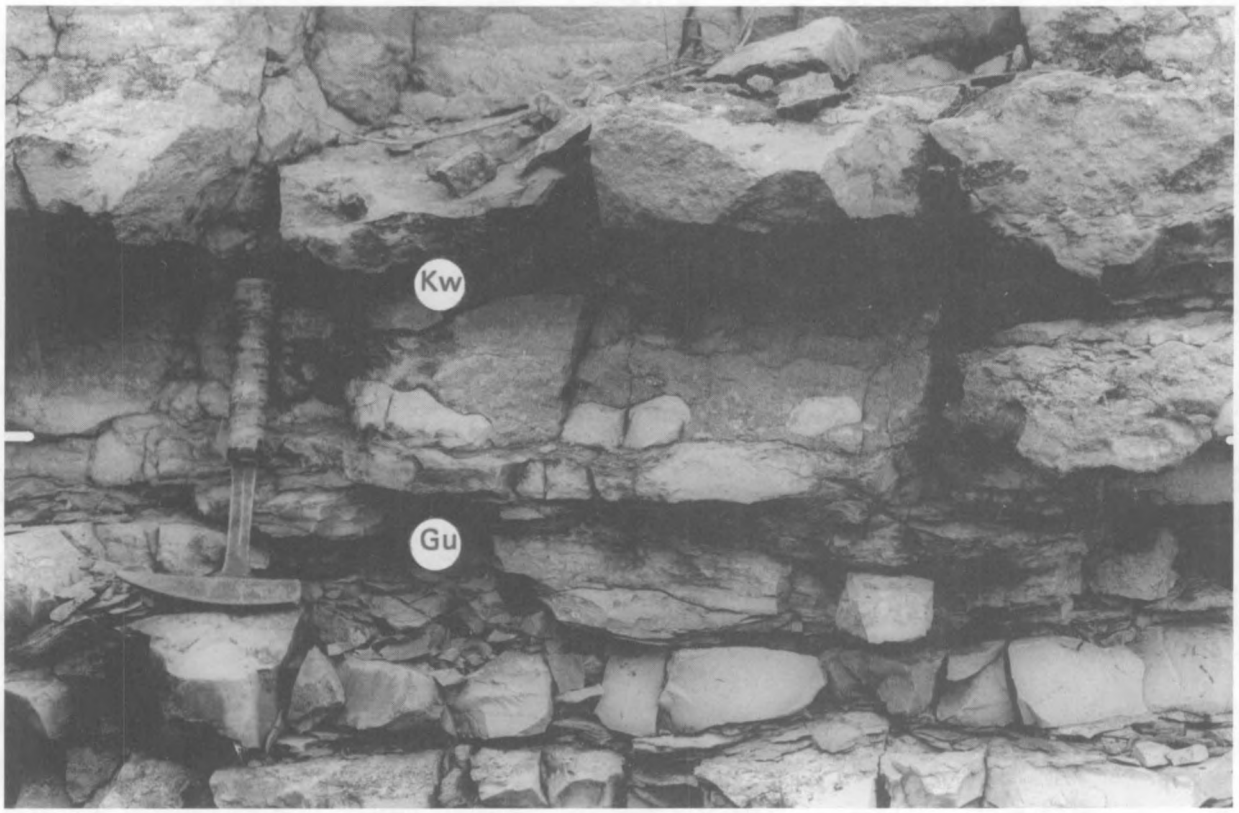


Figure 120 (A)

Figure 120 (B)

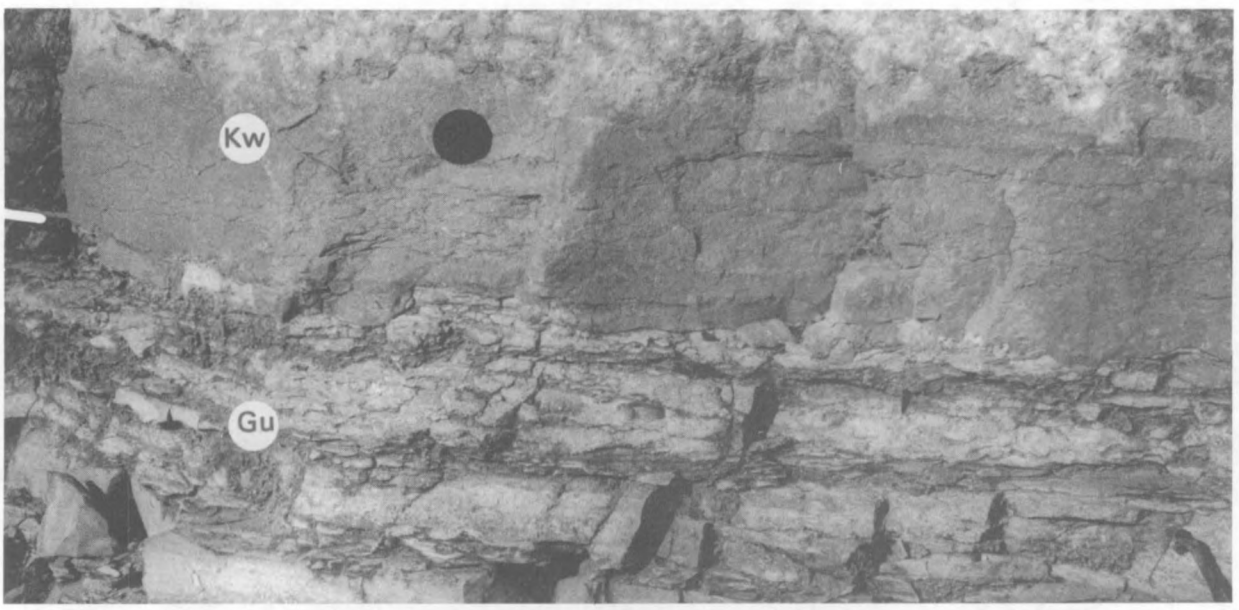


Figure 120. *Contact of* **Guttenberg Limestone (Gu)** *and Kimmswick Limestone* **(Kw)**, *Ralls County, Missouri..* **(A)** *A quarry on the west side of U.S. Highway 61, 2 mi north of New London, NE¼ NW¼ sec. 36, T. 56 N., R. 5 W. (fig. 119).* **(B)** *Roadcut on U.S. Highway 61 north of Spencer Creek, SE¼ SE¼ sec. 21, T. 55 N., R. 4 W. (figs. 75 and 110A). Photographs by T.L. Thompson.*

Kimmswick Limestone

Ulrich, 1904

Original description -- (Ulrich, 1904, p. 111) "The Kimmswick limestone is a new name referring to the more or less crystalline limestone being quarried at Graysboro, Cape Girardeau, Glen Park, Kimmswick and other localities in southeastern Missouri. The thin bed generally found at the top, 2 to 5 feet, holding the Fernville Richmond fauna, is not included."

Templeton and Willman (1963, p. 114) stated, "In Illinois the Kimmswick Subgroup consists of the Dunleith (below) and Wise Lake Formations. This follows the broad usage of Kimmswick to include strata higher than those present in the type section, which does not include the uppermost Dunleith and Wise Lake strata. It extends the usage of the term to equivalent, relatively pure dolomite strata in northern Illinois instead of restricting it to the limestone facies."

Type section -- Ulrich (1904) named this formation for exposures at Kimmswick, Jefferson County, Missouri. Bradley (1925, p. 50) stated, "The type exposures of the Kimmswick are in Jefferson County, Missouri, close to the Mississippi River, in the vicinity of the village of Kimmswick, about 20 miles south of St. Louis, and thence southward in a narrow belt along the river to the vicinity of Riverside, 8 miles distant." Although no specific type section was designated for the Kimmswick, exposures in an old open and underground quarry in the Kimmswick, at Glen Park, approximately 3 mi south of the town of Kimmswick (fig. 121), in the SE¼ NW¼ sec. 5, T. 41 N., R. 6 E., Jefferson County, Missouri, have collectively served as type for these strata. These exposures are not easy to see in detail.

Reference sections -- The entire Kimmswick Limestone can be studied in exposures in roadcuts and in a small quarry adjacent to I-55, just north of the junction with Highway M (figs. 122 and 123), 1.5 mi southwest of Kimmswick, in the south half of sec. 19 and north half of sec. 30, T. 42 N., R. 6 E., Jefferson County, eastern Missouri, Herculaneum 7½' Quadrangle. More accessible than the type section, these exposures show both upper and lower contacts of the Kimmswick.

Basal Kimmswick rocks are exposed in roadcuts on I-55 in the NW¼ SW¼ NW¼ sec. 6, T. 41 N., R. 6 E., Jefferson County, Herculaneum 7½' Quadrangle (figs. 107 and 108A); and in a roadcut on U.S. Highway 61 immediately north of the bridge over Spencer Creek (figs. 75 and 120B), SE¼ SE¼ sec. 21, T. 55 N., R. 4 W., Ralls County, northeastern Missouri, Hannibal SE 7½' Quadrangle (see also under **Guttenberg Limestone**).

Nearly the entire Kimmswick, and the underlying Guttenberg Limestone, are exposed in an old quarry immediately west of U.S. Highway 61, 2.0 mi north of New London (figs. 119 and 120A), NE¼ NW¼ and center north line, sec. 36, T. 56 N., R. 5 W., Ralls County, New London 7½' Quadrangle. Most of the Kimmswick is exposed in a roadcut on U.S. 61 (type section of Templeton and Willman's **New London Member**), approximately 0.25 mi northeast of this quarry (figs. 124 and 125A).

Another nearly complete exposure of the Kimmswick Limestone is a succession beginning in a bluff on the north side of Peno Creek, SW¼ NW¼ SW¼ sec. 1, continuing in a roadcut on the west side of U.S. Highway 61 (figs. 125B and 126), approximately 0.75 mi southeast of Frankford, and ending in the center SE¼ NE¼ sec. 2, T. 54 N., R. 4 W., Pike County, northeastern Missouri, Frankford 7½' Quadrangle. Templeton and Willman (1963, p. 125) listed the following succession for this exposure:

Wise Lake Formation
  Sinsinawa Member (28 ft)
Dunleith Formation
  New London Member (32 ft)
  Moredock Member (38 ft)

The uppermost (youngest) Kimmswick rocks exposed in Missouri are in sections in the vicinity of McCune (formerly "McCune's Station"), in the east bank of Peno Creek immediately south of the Highway U bridge, SE¼ NW¼ SE¼ sec. 32, T. 54 N., R. 3 W., Pike County, Frankford 7½' Quadrangle (fig. 127). This is the section from which Keyes (1898) named the "McCune limestone." At this exposure Templeton and Willman (1963) identified both members of the "Wise Lake Formation," the lower Sinsinawa Member and upper **Stewartville Member**, the latter containing abundant *Receptaculites* (now called *Fisherites*), identifying the "upper *Receptaculites* zone."

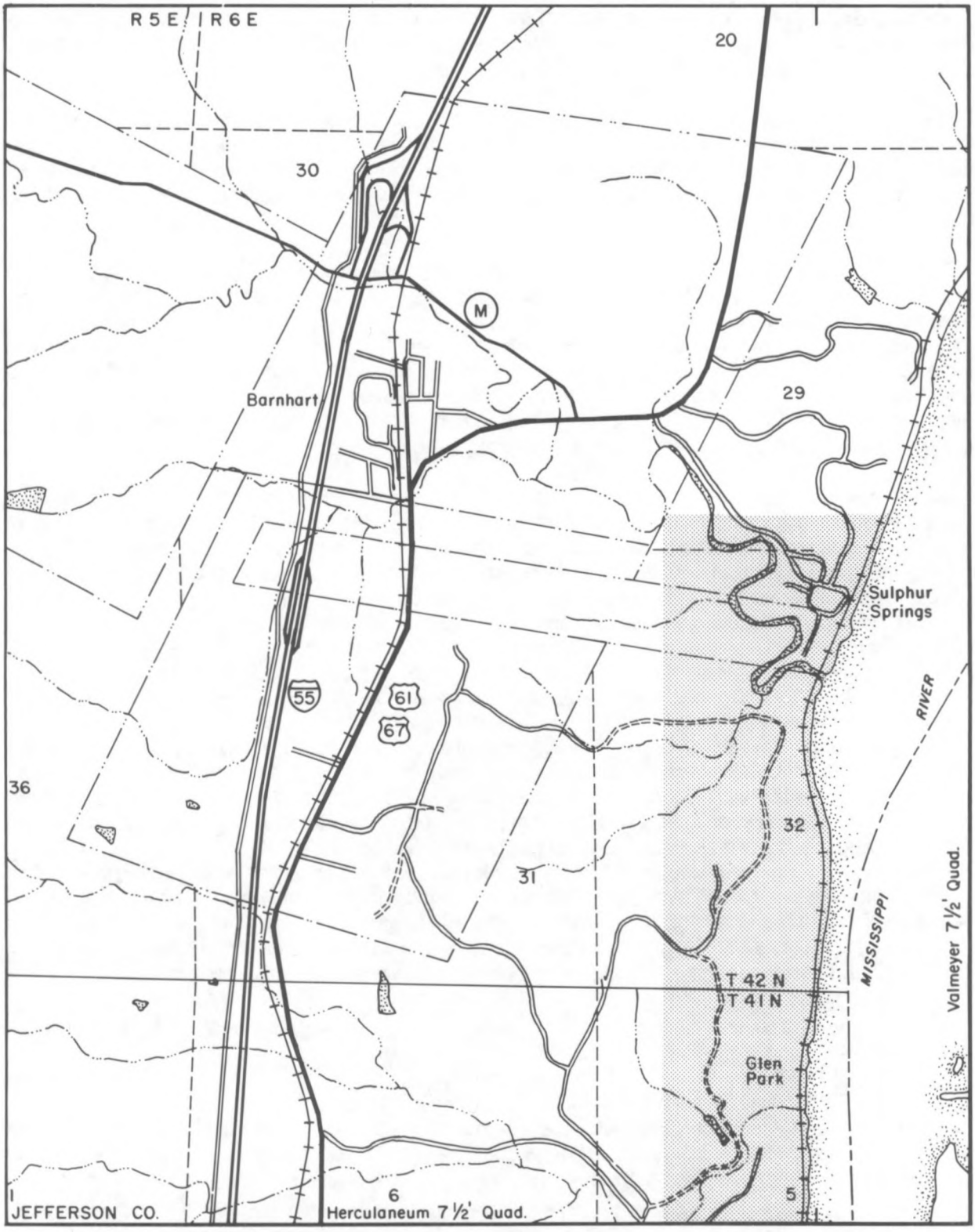
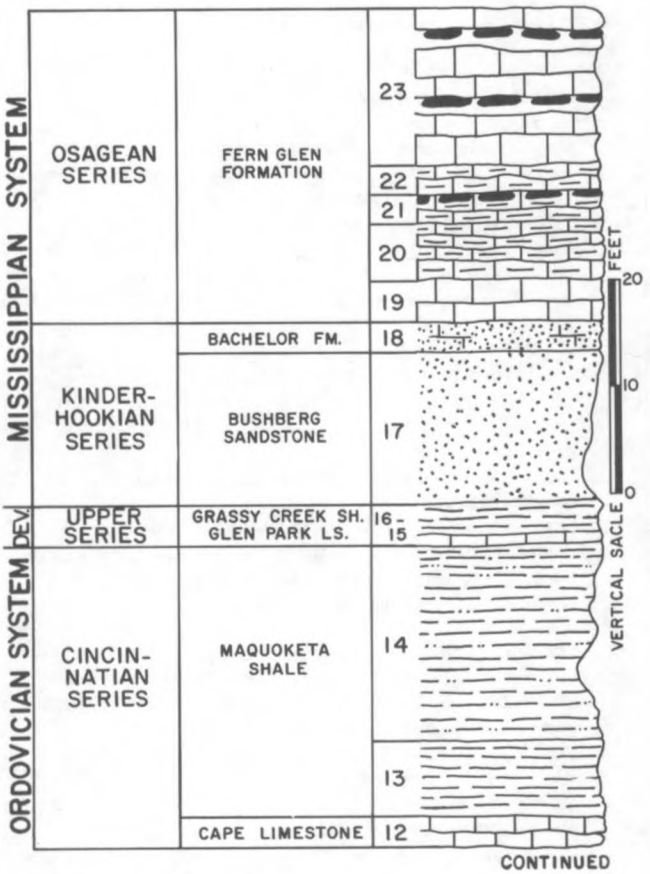


Figure 121. *Part of the Herculaneum and Valmeyer 7½' quadrangles, showing the location of the type area of the* **Kimmswick Limestone,** *near center sec. 5, T. 41 N., R. 6 E., Jefferson County, Missouri.*



MISSISSIPPIAN SYSTEM - OSAGEAN SERIES (24 ft)

Fern Glen Formation (24 ft)

23. Limestone, light-brown to light-gray - weathers buff-gray, fine to coarsely crystalline; thin to massively bedded; very fossiliferous; alternating beds of limestone and chert. (12 ft)
22. Limestone, reddish-brown, very shaly; like no. 20. (2 ft)
21. Limestone, light-gray, finely crystalline, argillaceous; very fossiliferous; 4-6 in. chert bed in upper part. (2 ft)
20. Limestone, red, finely crystalline, very shaly; thin, highly irregular beds; fossiliferous. (5 ft)
19. Limestone, light-brown-tan - weathers greenish-gray, finely crystalline, massive; abundant fossils. (3 ft)

KINDERHOOKIAN SERIES

Bachelor Formation (2-3 in.)

18. Sandstone, greenish-gray, slightly calcareous, nodular; sand grains rounded and frosted. (2-3 in.)

Bushberg Sandstone (13 ft 6 in.)

17. Sandstone, yellow-brown, medium grained, well-sorted, very friable; grains rounded and frosted. (13 ft 6 in.)

DEVONIAN SYSTEM - UPPER SERIES (3 ft 6 in.)

***SULPHUR SPRINGS GROUP* (3 ft 6 in.)**

unnamed (Grassy Creek) shale (3 ft 3 in.)

16. Shale, medium-gray, very fissile; abundant graptolites, *(Climacograptus mississippiensis)*. (3 ft 3 in.)

Glen Park Limestone (3 in.)

15. Limestone, dark-gray, finely crystalline, very sandy; contains phosphatic material. (3 in.)

ORDOVICIAN SYSTEM - CINCINNATIAN SERIES

Maquoketa Shale (24 ft 10 in.)

14. Shale, gray to greenish-gray, appears silty, fissile; abundant graptolites *(Orthograptus truncatus socialis)*; phosphatic debris; possible bentonite at base. (17 ft 4 in.)
13. Shale, gray; thin-bedded; appears to be mudstone. (7 ft 6 in.)

Section below from road level, into quarry, and to roadcut south at off ramp to Jefferson County road M.

Cape Limestone (1-2 ft)

12. Limestone, medium-gray, coarse-grained calcarenite; brachiopods and other fossils abundant. (1-2 ft)

Figure 122. **Kimmswick Limestone, Cape Limestone, Maquoketa Shale,** *and overlying Mississippian formations in roadcuts and an adjacent quarry on I-55, north of the Barnhart (Highway M) interchange, center north line sec. 30, center south line sec. 19, T. 42 N., R. 6 E., Jefferson County, Missouri, Herculaneum 7½' Quadrangle. Described by T.L. Thompson, 1987. Graptolite horizons reported by Berry and Marshall (1971).*

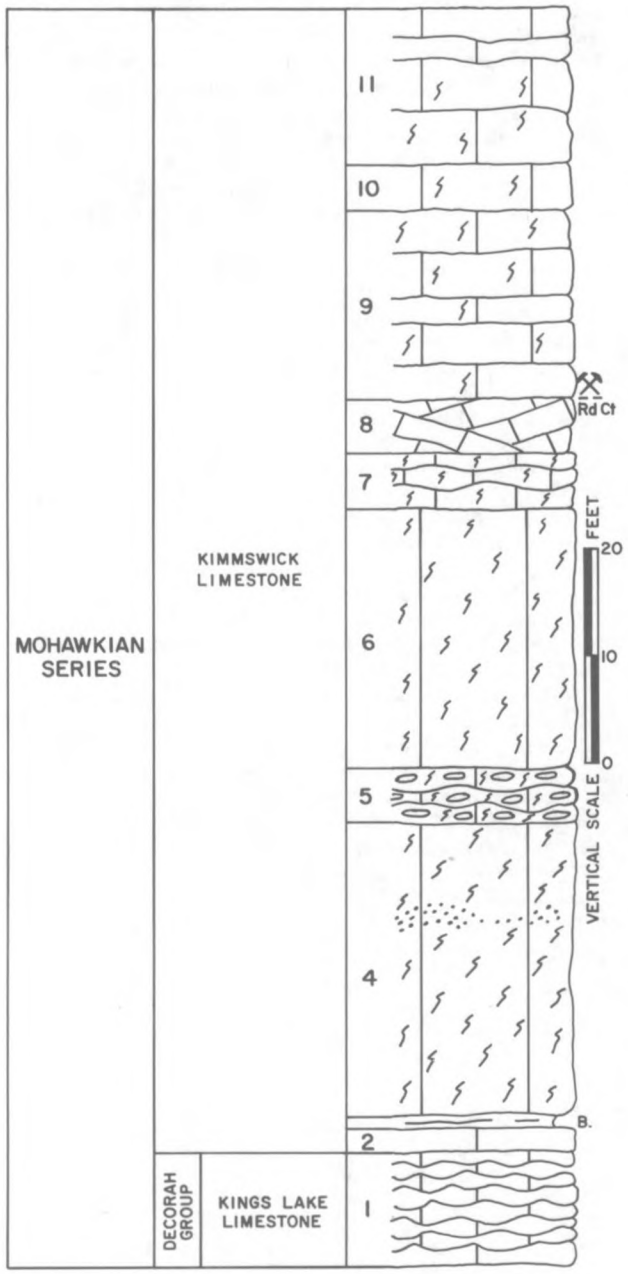


Figure 122 (cont)

MOHAWKIAN SERIES

Kimmswick Limestone (109 ft)

11. Limestone, light-gray, medium-crystalline biomicrite, beds uneven, but massive; burrowing not evident; stylolitic. (15 ft)
10. Limestone, light-gray, medium to coarsely crystalline, very fossiliferous; weathers to thin, slabby beds. (4 ft)
9. Limestone, light gray, coarsely crystalline, very fossiliferous, massive even 1-2 ft stylolitic beds; appears unburrowed; base at top of heavily burrowed limestone. Uniform textured, medium crystalline biomicrite 15 ft above base. Unit begins 10 ft above quarry floor; base close to top of unit 8 in roadcut. (18 ft)

Units 1-8 in roadcut at off-ramp to Jefferson County road M.

8. Limestone, gray, coarsely crystalline, cross-laminated; very fossiliferous, burrowed; single massive bed. Top of unit at north end of roadcut. (6 ft)
7. Limestone, light-gray, medium-crystalline biomicrite; burrowed; 1-3 ft beds. (6 ft)
6. Limestone, light-gray, coarsely crystalline biomicrite, "crinoidal," burrowed, cross-laminated; very fossiliferous; single massive bed. Top 6 ft very coarsely crystalline, with large fossils; brachiopods, crinoids, *Receptaculites*. Top at prominent stylolite. (24 ft)
5. Limestone, light-gray, fine to medium crystalline, very nodular or irregularly bedded; burrowed; very cherty. Chert brown, as scattered nodules and discontinuous beds. Top and base of unit sharply defined. (6 ft)
4. Limestone, light gray, medium to coarsely crystalline; massive, stylolitic single bed; burrowed. Weathers to thin beds. Small reef-like mounds 18 ft above base. Upper 3 ft a very fossiliferous biomicrite. (28 ft)
3. **House Springs K-bentonite**, shale, green, and yellow brown; interbedded with thin slabby beds of coarsely crystalline, fossiliferous limestone. (6 in. - 1 ft)
2. Limestone, light-gray, fine to medium crystalline; single bed; large 1-3 in. brown chert nodules in center of bed; "welded" contact with unit no. 1. (2 ft)

DECORAH GROUP

Kings Lake Limestone (12 ft+)

1. Limestone, gray, finely crystalline to sublithographic; in thin 1-3 in. nodular, wavy beds interbedded with dark gray, calcarenous shale. Base at road level of off-ramp. (12 ft)

History of nomenclature

1855	Shumard	Trenton Limestone Receptaculite limestone Cape Girardeau marble of Trenton
	Swallow	Trenton Limestone
1866	Worthen	Galena limestone (upper Trenton group)
1873	Broadhead	Charette limestone
	Pumpelly	Charette or Receptaculite limestone
	Shumard	Receptaculite limestone
1891	Rowley	Trenton limestones (upper part)
1897	Sardeson	Galena series

1898	Keyes	McCune limestone of Trenton limestone
1904	**Ulrich**	**Kimmswick limestone**
1908	Savage	Galena-Trenton formation ("resembles Kimmswick limestone of Ulrich")
1910	Schuchert	Kimmswick limestone Glencoe marble
1914	Keyes	McCune limestone
1921	Dake	Kimmswick limestone
1922	Keyes	Julian limestone
1923	Keyes	McCune limestone (rejected "Kimmswick")
1925	Bradley	Kimmswick limestone ("Receptaculites limestone," or Trenton)
1933	Scott	Kimmswick formation (= Galena of northwestern Illinois)
1934	Shimer	McCune limestone
1937	Keyes (a, c)	Charette limestone (rejected "McCune" and "Kimmswick")
	Kay	McCune (=Stewartville; upper Trenton) Kimmswick
1941	Keyes	Charette limestone
1947	Taylor	Kimmswick limestone Viola limestone of Kansas Prosser limestone of Iowa
1954	Twenhofel et al.	Kimmswick limestone (with McCune limestone in northeastern Missouri)
1961	Martin et al. (a)	Kimmswick formation
1963	**Templeton and Willman**	**Kimmswick Subgroup of Galena Group** **Dubuque Formation** **Wise Lake Formation** **Stewartville Member** **Sinsinawa Member** **Dunleith Formation** **New London Member** (Wall Member) (Sherwood Member) **Moredock Member** (Rivoli Member) (Mortimer Member) (Fairplay Member) **Eagle Point Member** **Beecher Member** **St. James Member**
1966	Echols and Levin	Kimmswick Limestone
1968	Stinchcomb and Fellows	Kimmswick Formation
1970	Kay	Galena Group (upper part) Dubuque Formation Stewartville Dolomite Prosser Limestone
1975	Sweet et al.	Kimmswick Formation
	Thompson and Satterfield	Kimmswick Formation
1978	Willman and Kolata	Kimmswick Subgroup Dubuque Formation Wise Lake Formation Dunleith Formation Wyota Member Loves Park Member

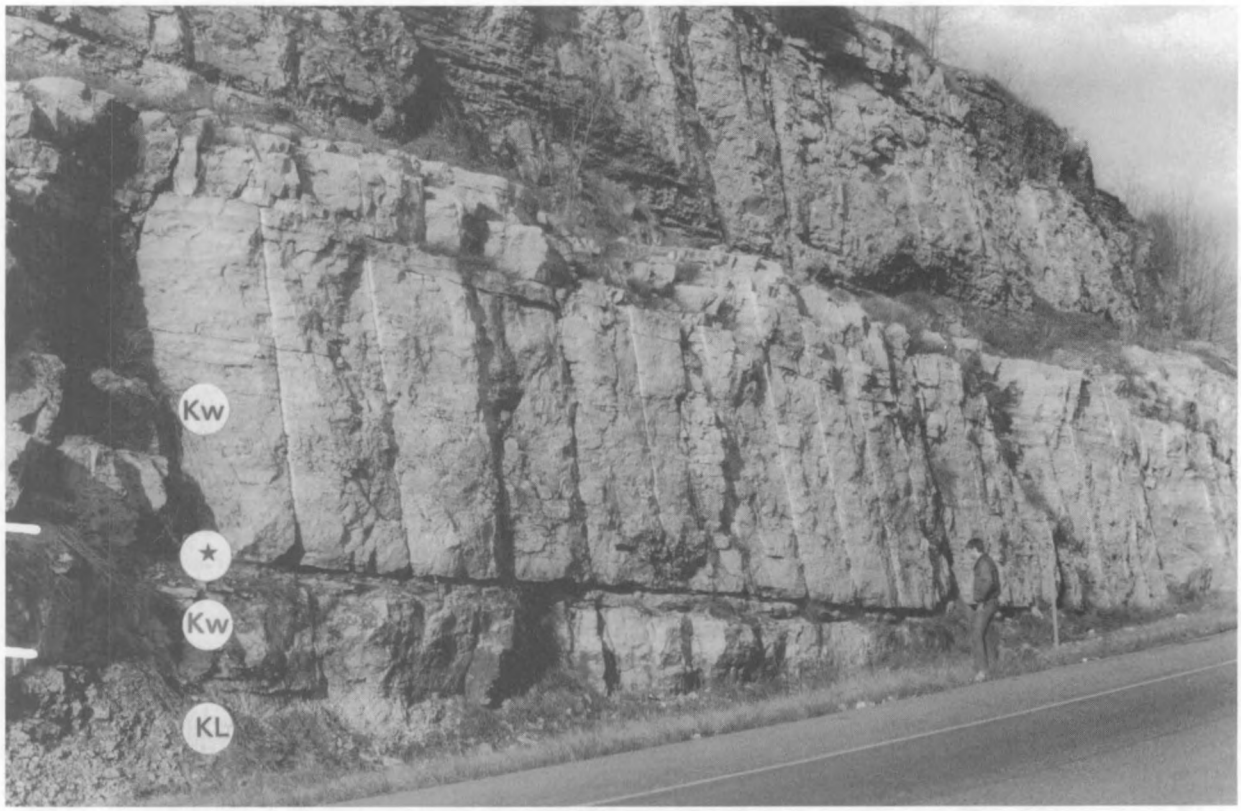
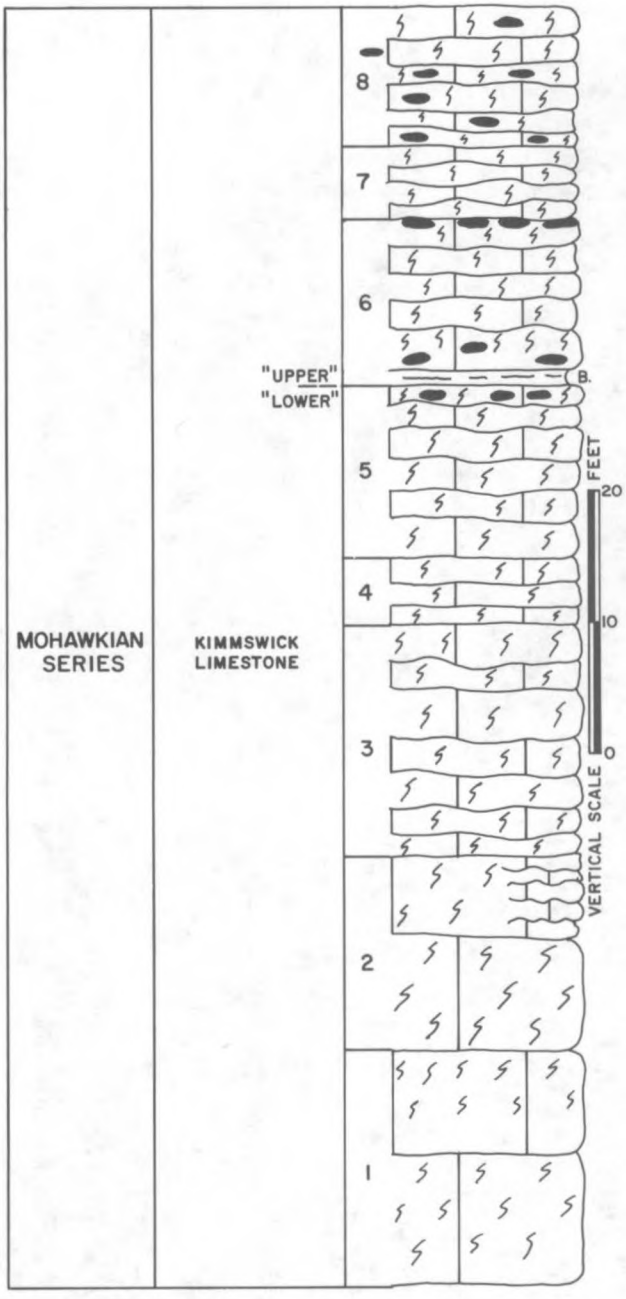


Figure 123. *Upper Decorah Group* **Kings Lake Limestone (KL)** *and lower part of the* ***Kimmswick Limestone*** **(Kw)** *in a roadcut on I-55 at the interchange with Highway M at Barnhart (fig. 122), Jefferson County, Missouri.* **(*) = *House Springs K-bentonite Bed.*** *Photograph by T.L. Thompson.*

		(Wall Member)
		(Sherwood Member)
		(Rivoli Member)
		(Mortimer Member)
		Fairplay Member
		Eagle Point Member
		Beecher Member
		St. James Member
		Buckhorn Member
1979	Offield and Pohn	Kimmswick Limestone
1982	Thompson	Kimmswick Formation
1986	Kolata et al.	Kimmswick Subgroup
		Dunleith Formation
		House Springs K-bentonite Bed
	Bakush and Carozzi	Kimmswick Subgroup of Galena Group
1987	Thompson	Kimmswick Limestone (part; included Kings Lake Limestone)
1991	**Thompson (present report)**	**Kimmswick Limestone**
		"upper Kimmswick Limestone"
		"lower Kimmswick Limestone"
		House Springs K-bentonite Bed



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES
Kimmswick Limestone (100 ft)
"upper Kimmswick Limestone" (28 ft)

8. Limestone, gray to brown, finely crystalline, in alternating beds of very finely crystalline debris or "rip storm beds," and thin calcarenitic beds; less argillaceous than unit no. 7; heavily burrowed; abundant *Receptaculites*; brown chert as scattered small nodules; entire unit highly weathered. (10 ft)
7. Limestone, dark gray to light gray, fine to coarsely crystalline; nodular bedded limestone with numerous shale partings; weathers argillaceous; base at discontinuous chert bed. (6 ft)
6. Limestone, fine to medium crystalline, interbedded with thin coarsely crystalline beds; burrowed; scattered *Receptaculites*; chert as small brown scattered nodules in lower 3 ft and prominent discontinuous beds of nodules at top; base at reentrant (K-bentonite). (12 ft)

"lower Kimmswick Limestone" (72 ft)

5. Limestone, gray, medium to coarsely crystalline; highly burrowed, with 6-in. to 1-ft unborrowed zones; weathers nodular; top at thin ½-1 in. K-bentonite (reentrant); brown chert as small scattered nodules in upper 2 ft; *Receptaculites* abundant (18 ft)
4. Limestone, gray, very coarsely crystalline; thin to thick beds; burrowed, but not as heavily as unit no. 3; very fossiliferous, *Receptaculites*. (5 ft)
3. Limestone, gray, medium to coarsely crystalline; burrowed; fossiliferous; thin to medium bedded; small scattered calcite nodules; weathers to thin nodular beds. (18 ft)
2. Limestone, medium to coarsely crystalline; burrowed; massive thick beds; base begins at road level at south end of roadcut; weathers thin and shaly in some parts. (12 ft)
1. Limestone, like unit no. 2; very massive, thick beds; forms bluff to valley floor at south end of roadcut. (18 ft+)

Figure 124. **Kimmswick Limestone** *in a roadcut on U.S. Highway 61, 2.5 mi north of New London, north of the bridge over the Salt River, center E½ W½ sec. 25, and in a quarry immediately west of the highway, NE¼ NE¼ and center north line sec. 36, T. 56 N., R. 5 W., Ralls County, Missouri. Description by T.L. Thompson, 1987.*

Remarks -- Martin et al. (1961a, p. 28) stated that, in outcrop,

"The Kimmswick [in Missouri] is typically a coarsely crystalline, white to light gray, medium bedded to massive limestone. The weathered surface of the rock is distinctive in that it is notably pitted or 'honeycombed'. Chert is nodular and irregularly scattered locally in the upper part of the formation. Invertebrate fossils, predominantly brachiopods and bryozoans, are common throughout the formation. The 'sunflower coral,' *Receptaculites oweni*, characterizes the Kimmswick in Missouri. Regionally, the Kimmswick is unconformable on underlying units.

"In much of the subsurface of north-central and northwestern Missouri, the Kimmswick is a dolomite which contains interbedded limestone. This is especially true in the Forest City basin in northwestern Missouri. The Kimmswick is also a dolomite in the faulted areas of Perry and Ste. Genevieve Counties, where it is commonly gray to grayish brown, coarsely to medium crystalline and contains chert.

"The Kimmswick is 50 to 150 feet thick in eastern Missouri and attains a thickness of more than 250 feet in northwestern Missouri. In the north-central part of the state, it thins over a regional anticlinal high."

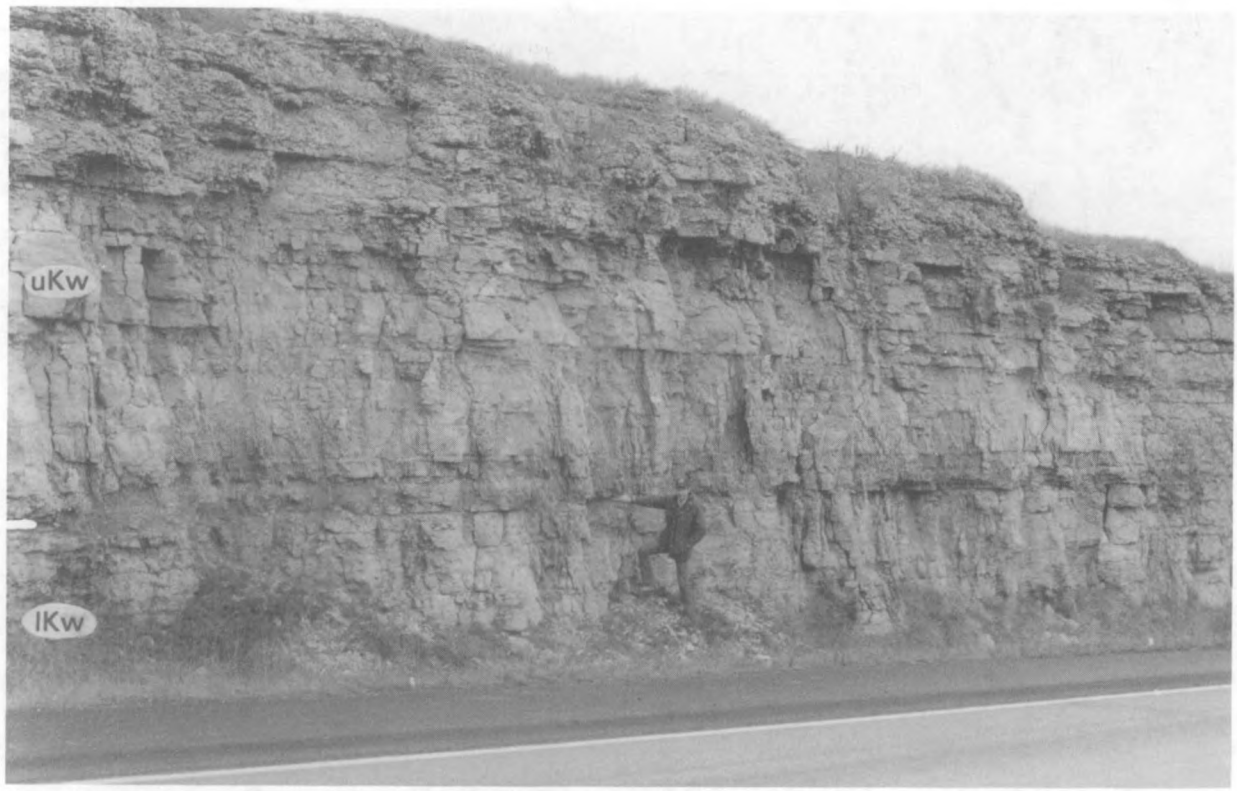
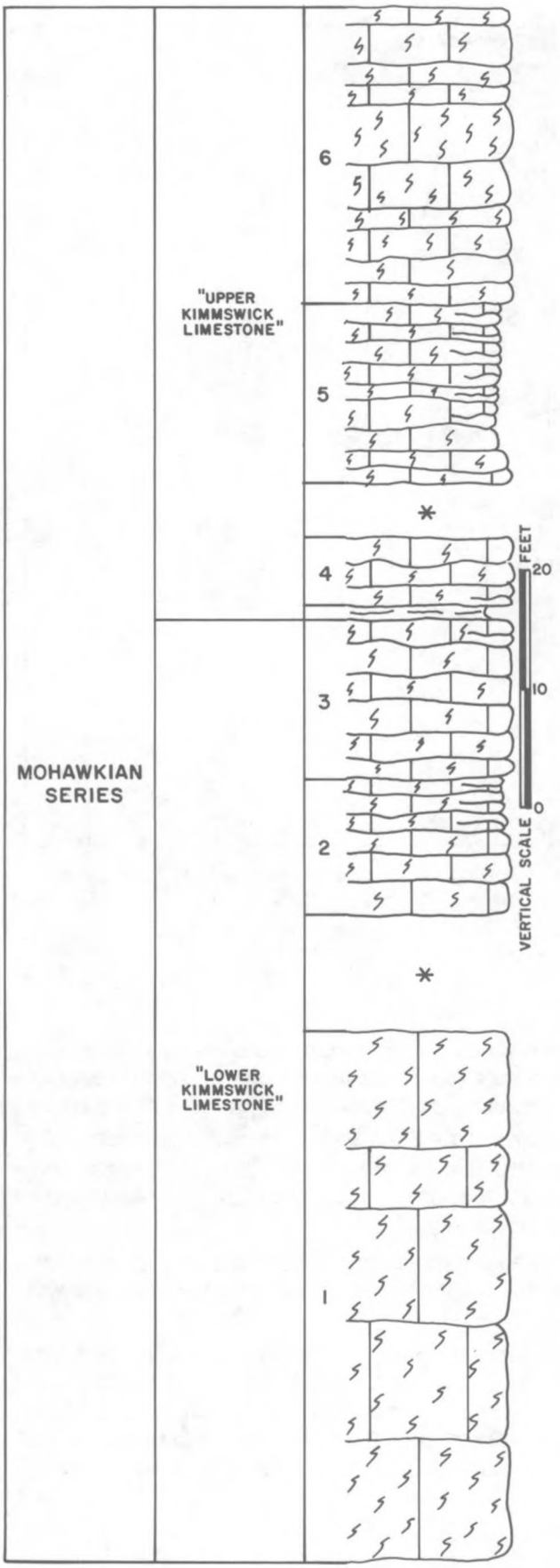


Figure 125 (A) ▲ Figure 125 (B) ▼

Figure 125. *Contact between the* **"upper Kimmswick Limestone" (uKw)** *and* **"lower Kimmswick Limestone" (lKw).** **(A)** *Roadcut on the east side of U.S. Highway 61, 2.5 mi north of New London, center E½ W½ sec. 25, T. 56 N., R. 5 W., Ralls County (fig. 124).* **(B)** *Roadcut on the west side of U.S. Highway 61, 0.75 mi southeast of Frankford SW¼ NW¼ SW¼ sec. 1 to SE¼ NE¼ sec. 2, T. 54 N., R. 4 W., Pike County, Missouri (fig. 126). Photographs by T.L. Thompson.*



ORDOVICIAN SYSTEM - MOHAWKIAN SERIES

Kimmswick Limestone (137 ft)

"upper Kimmswick Limestone" (51 ft)

6. Limestone, light-tan, very fine-grained calcarenite to sublithographic; becomes more lithographic upward; beds dense, medium thick, highly burrowed, fossiliferous; *Receptaculites* most abundant in upper 6-8 ft; a few thin medium-grained calcarenite beds. (25 ft)
5. Limestone, light-gray, very fine-grained calcarenite, thick-bedded, highly burrowed; weathers blocky to slabby; forms slight reentrant; *Receptaculites* scattered throughout, but most abundant in lower 6 ft; some 1-2-in. continuous medium-grained calcarenite beds. (15 ft)

Covered interval (ravine). (5 ft)

4. Limestone, light-gray, fine-grained calcarenite, thick-bedded, highly burrowed; base at top of 3-6-in. reentrant in shale and bentonite bed. (6 ft)

"lower Kimmswick Limestone" (86 ft)

3. Limestone, light-gray, medium-grained calcarenite, heavily burrowed; some fine-grained zones; beds 6 in. to 1 ft thick; *Receptaculites* abundant; top at prominent bentonite bed (reentrant). (14 ft)
2. Limestone, medium- to coarse-grained calcarenite, thin- to medium-bedded (1-6 in.), highly burrowed; very fossiliferous zones (brachiopods); top beneath prominent 1-ft overhang 1-2 ft above road level. (12 ft)

Covered interval. (10 ft)

1. Limestone, gray, medium- to coarse-grained calcarenite; forms bluff on north side of Peno Creek. (50 ft)

Figure 126. **Kimmswick Limestone** *exposed in a roadcut on the west side of U.S. Highway 61, 0.75 mi southeast of Frankford, SW¼ NW¼ SW¼ sec. 1 to SE¼ NE¼ sec. 2, T. 54 N., R. 4 W., Pike County, Missouri (fig. 125B). Description by T.L. Thompson, 1987.*

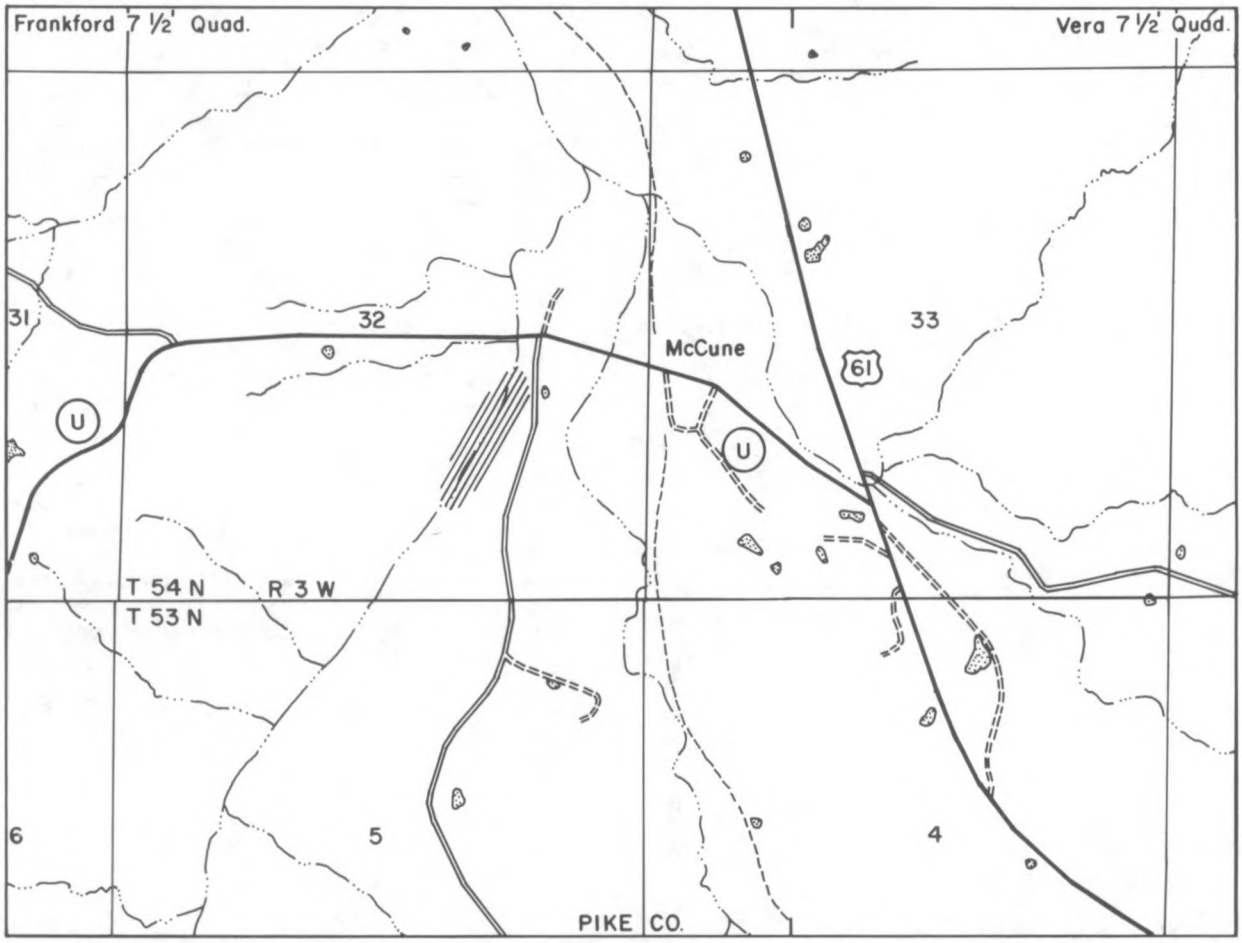


Figure 127. *Part of the Frankford and Vera 7½' quadrangles showing the location of exposures of the uppermost* **Kimmswick Limestone** *("McCune limestone" of Keyes), SE¼ NW¼ SE¼ sec. 32, T. 54 N., R. 3 W., Pike County, Missouri.*

The upper contact of the Kimmswick Limestone is unconformable; in various places the Late Ordovician Cape Limestone (southeastern Missouri), Maquoketa Shale (east-central and northeastern Missouri), Middle Devonian Callaway Limestone (northeastern Missouri), or Early Mississippian Bushberg Sandstone (east-central Missouri) may be found directly overlying the Kimmswick. The upper surface of the Kimmswick has been extensively eroded; in many places the formation has been entirely removed or considerably thinned by several periods of erosion (fig. 128) that are post-Cincinnatian, post-Middle Devonian, post-Mississippian, and possibly post-Pennsylvanian in age.

The basal contact is also disconformable, a condition particularly noticeable in northeastern Missouri, where pebbles of the underlying Guttenberg Limestone are incorporated into the basal Kimmswick (fig. 120).

Templeton and Willman (1963) divided the "Kimmswick Subgroup" in the Illinois Basin into three formations, each of which was divided into members (fig. 129). Only the lower two formations, the **Dunleith** and **Wise Lake**, were identified in Missouri. They correlated the uppermost formation, the **Dubuque Formation** of Iowa and northern Illinois, with the early Late Ordovician (Cincinnatian) **Cape Limestone** of southeastern Missouri. The Dunleith and Wise Lake Formations are composed of the following members:

Wise Lake Formation
- Stewartville Member
- Sinsinawa Member

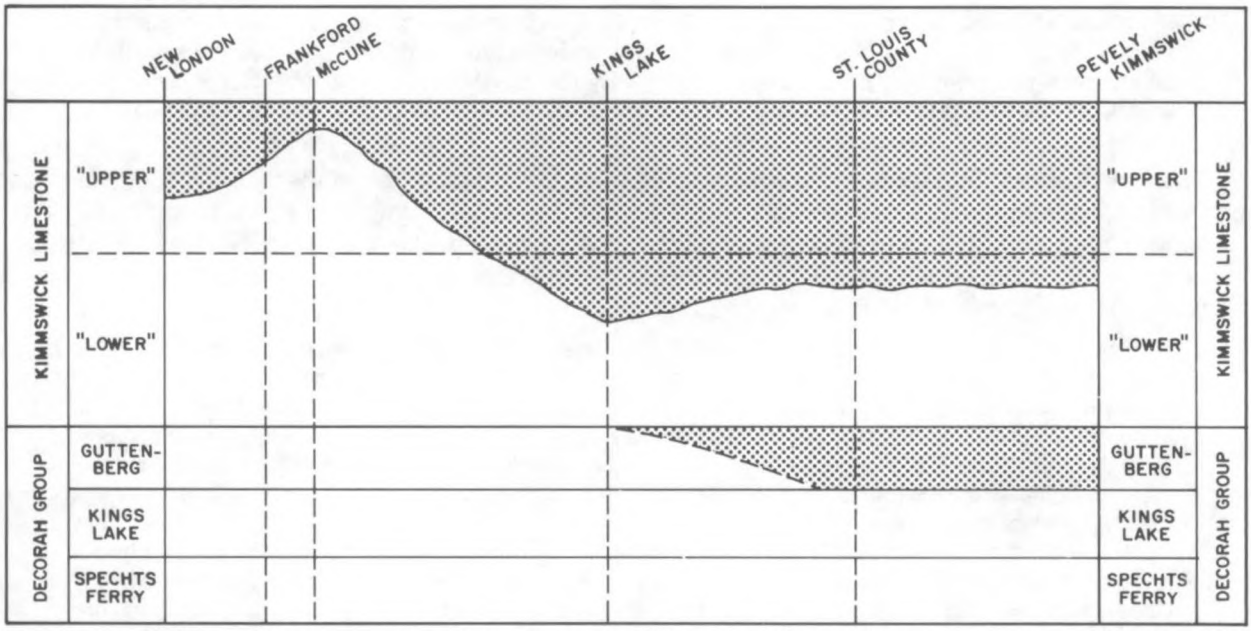


Figure 128. *Diagrammatic cross-section of the* **Kimmswick Limestone** *from northeastern to southeastern Missouri, showing nature of the eroded upper surface and amount of section removed before deposition of the overlying Maquoketa Group. Adapted from Templeton and Willman (1963).*

Dunleith Formation
- New London Member (northeastern Missouri only)
- Moredock Member (east-central and southeastern Missouri)
- Eagle Point Member
- Beecher Member
- St. James Member

South of Ralls and Pike counties, northeastern Missouri, Templeton and Willman assigned most exposed Kimmswick to the **Dunleith Formation** of the Illinois Basin classification (fig. 129); they identified the only **Wise Lake** strata in Missouri in Pike and Ralls counties.

A basic description of the Kimmswick of Missouri by Templeton and Willman (1963, p. 118-119) is as follows:

> "The Dunleith Formation in Missouri and southern Illinois consists of an upper cherty, partly argillaceous, lithographic, and calcarenitic limestone, and a lower coarse-grained calcarenite. As elsewhere in the Mississippi Valley region, the top of the cherty argillaceous limestone in the Galena Group marks the top of the Dunleith Formation.
>
> "This correlation, based on subsurface tracing, is supported by the presence of a bentonite 40 to 45 feet below the top of the Dunleith Formation in Ralls and Pike Counties, Missouri. The bentonite appears to be equivalent either to a persistent bentonite at the base of the Sherwood Member in the northern outcrop belt, or to a bentonite about 4 feet above the base of the Sherwood [**Nasset Bentonite Bed** of Willman and Kolata, 1978]. In exposures near New London, Ralls County, and in outcrops south of St. Louis this bentonite is at the top of the coarse-grained calcarenite in the lower part of the Dunleith [the "Moredock" - "New London" contact; the boundary between the "upper" and "lower" Kimmswick in northeastern Missouri] and in the Main Street section at Cape Girardeau, Missouri, it is also at the top of the coarse calcarenite, the contact between the *Receptaculites* (below) and *Echinosphaerites* Zones (McQueen, 1939, p. 61-62). The prominent zone of *Receptaculites* is almost continuously present just below the bentonite from New London to Cape Girardeau and is believed to correspond to the persistent Middle *Receptaculites* Zone in the lower Sherwood and Rivoli strata of northern Illinois.
>
> "The northern Illinois members of the Dunleith Formation above the Eagle Point Member have not been differentiated in the southern outcrop area. These strata are divided into two distinct units separated by the bentonite previously mentioned. The lower unit consists of massive, pure, coarse, calcarenite, which contains rare, large, white, chert nodules. The name Moredock Member is proposed for this unit. For the

upper unit, which consists of cherty, partly argillaceous, lithographic and calcarenitic limestone with some beds of medium calcarenite, the name New London Member is proposed. Where the bentonite is absent between the two members, a sharp reentrant generally marks the contact. The Moredock is essentially equivalent to the Fairplay, Mortimer, and Rivoli Members, and the New London to the Sherwood, Wall, and Wyota Members of the northern outcrop area."

The **New London Member**, approximately 55 ft thick, was named from Ralls County, Missouri (type section described under "Reference sections"; figs. 124 and 125A). Templeton and Willman (1963) also described an exposure on Main Street, just north of the intersection with Broadway, in Cape Girardeau, Cape Girardeau County, Missouri (type section of the **Cape Limestone**) in which 8 ft of New London is exposed. They commented as follows (p. 125):

"The New London consists of fine- to medium-grained calcarenite and fine-grained to lithographic, calcarenitic limestone in medium beds, moderately pure, mostly cherty, with some thin argillaceous and weakly shaly beds. It is finer grained than the Moredock below but coarser than the Wise Lake above and less pure and thinner bedded than either. Red-brown shale partings occur locally, especially near the base at Cape Girardeau and 10 feet above the base near New London. A bed of bentonite, up to 2 inches thick, commonly marks the bottom of the member from the type area southward to Cape Girardeau, but it is missing in some exposures.

"The entire member is present in only the extreme northern part of the southern outcrop area where it appears to be 35 to 45 feet thick. South of Calhoun County, Illinois, the New London is overlapped by the Cape Limestone and the Elgin Shale of the Maquoketa Group. However, the lower 3 to 5 feet occurs locally, as at Glen Park, Brickeys, and Cape Girardeau, Missouri. In the vicinity of Cape Girardeau and Thebes, Illinois, as much as 30 feet of cystoid-bearing limestone, possibly all New London, is reported to be present at places (Ulrich, 1911, p. 309-310), but it was not found during our study. In the section at Cape Girardeau, the New London Member is 8 feet thick and has a bentonite at the base."

Of the more restricted **Wise Lake Formation** in northeastern Missouri, Templeton and Willman stated (1963, p. 126),

"The Wise Lake Formation is present throughout the northern outcrop area [Wisconsin, Iowa, Minnesota] and in the subsurface southward to outcrops in Ralls and Pike Counties, Missouri, but it is absent farther

<table>
<tr><th colspan="2">TEMPLETON & WILLMAN (1963)</th><th>PRESENT REPORT</th></tr>
<tr><td colspan="2">Dubuque Formation (Sardeson, 1907)</td><td></td></tr>
<tr><td colspan="2">Wise Lake Formation
Stewartville Member (Ulrich, 1911)
Sinsinawa Member

Dunleith Formation</td><td rowspan="2">"Upper Kimmswick Limestone"</td></tr>
<tr><td>Wyota Member
Wall Member
Sherwood Member</td><td>*New London Member</td></tr>
<tr><td>Rivoli Member
Mortimer Member
Fairplay Member</td><td>Mordock Member</td><td rowspan="2">"Lower Kimmswick Limestone"</td></tr>
<tr><td colspan="2">Eagle Point Member
Beecher Member
St. James Member
Buckhorn Member</td></tr>
</table>

Figure 129. *Formations and members of the* **"Kimmswick Subgroup"** *as proposed by Templeton and Willman (1963). Member marked with an (*) was named from type section in Missouri.*

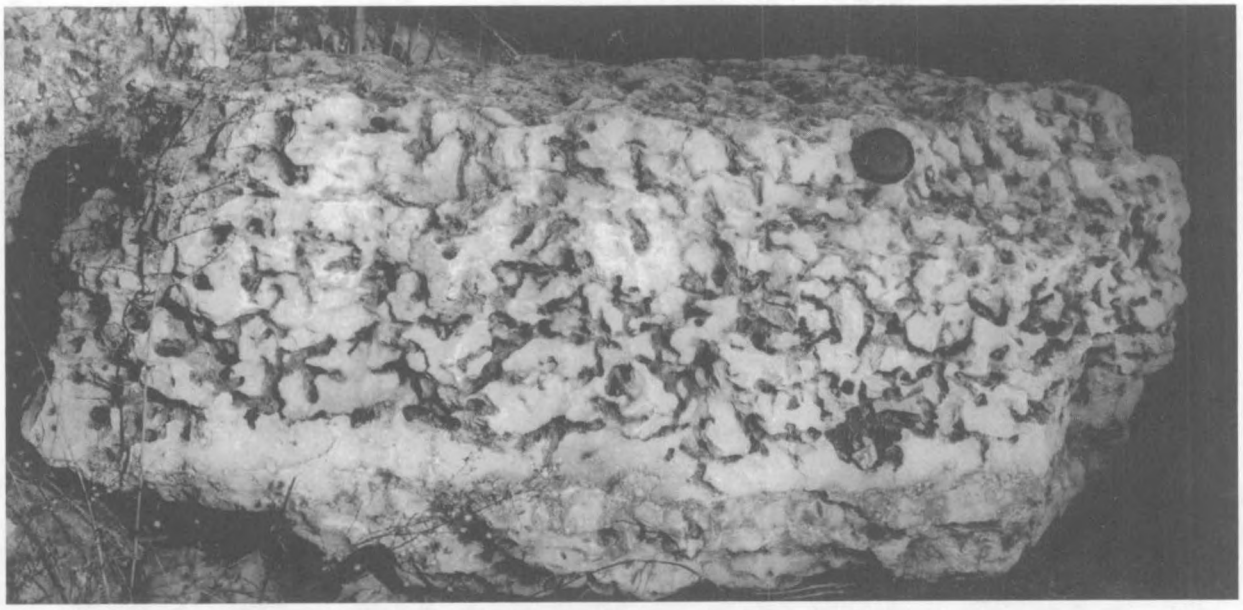


Figure 130 (A)

Figure 130 (B)

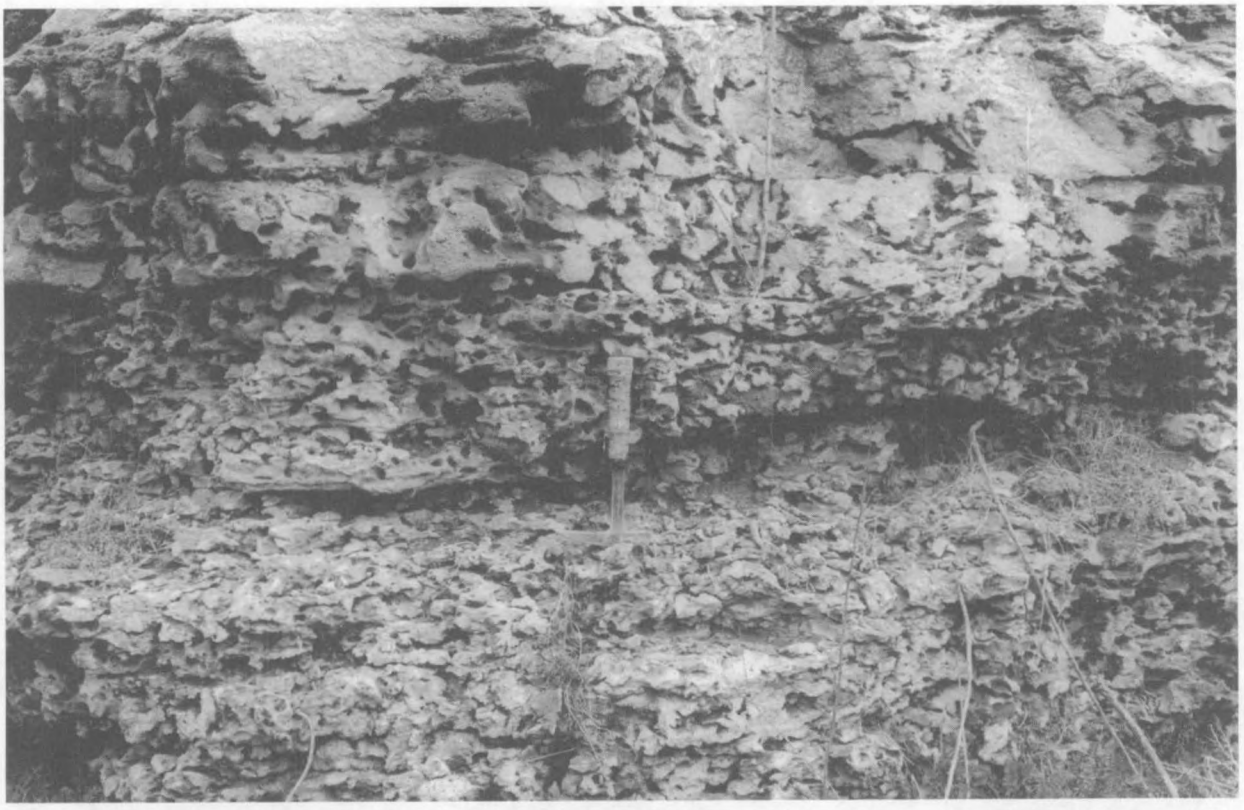


Figure 130. **Kimmswick Limestone.** **(A)** *"Lower Kimmswick Limestone" in roadcut on U.S. Highway 61 north of the bridge over Spencer Creek (fig. 75), SE¼ SE¼ sec. 21, T. 55 N., R. 4 W., Ralls County.* **(B)** *A block from the quarry 2 mi north of New London west of U.S. Highway 61, NE¼ NW¼ sec. 36, T. 56 N., R. 5 W. (figs. 119 and 120A), showing the characteristic weathering of the finely crystalline burrowed calcarenite of the "upper Kimmswick Limestone." Photographs by T.L. Thompson.*

> south. It is commonly 70 to 80 feet thick. As much as 50 feet may be present in the Missouri outcrop area. McQueen and Greene (1938, p. 41) report 45 feet of limestone above the cherty zone in the Kimmswick in northwestern Missouri."

Willman and Kolata (1978, p. 52) concluded,

> "The Wise Lake Formation represents the peak of purity in the Galena Group with an almost complete absence of siliceous terrigenous materials. A comparable degree of relative purity occurs in Trentonian strata from New York (**Steuben Member of the Cobourg Formation**) to Colorado (in the **Fremont Formation**) and from Manitoba (in the **Selkirk Member of the Red River Formation**) to Tennessee (in the upper **Cannon Member of the Bigby-Cannon Formation**), and comparable relations exist even more widely." [bold type mine.]

In the type region, as is most of the Kimmswick in Missouri, the Kimmswick Limestone is a coarse grainstone. Historically, however, this and the overlying cherty fine to medium grainstone of the "Dunleith" have all been identified as the Kimmswick Limestone. Because the limestone facies of northeastern Missouri differs considerably from the dolomite facies present in northern Illinois, the contact between the "Dunleith" and "Wise Lake," as defined in northern Illinois, is not recognizable. The only horizon the present author could identify with any degree of confidence was the K-bentonite bed that marked the base of the "New London Member of the Dunleith"; the upper boundary of the "New London" could not be identified. As Templeton and Willman named the "Dunleith" in 1963, "Kimmswick" (Ulrich, 1904) has priority over "Dunleith," and should be the valid name for this formation in Missouri.

The Kimmswick Limestone of the type region, a coarse bioclastic, heavily burrowed grainstone (fig. 130A), can readily be distinguished from the other Mohawkian limestones of the Plattin and Decorah Groups, which are mudstones to fine grainstones. Kimmswick Limestone exposed in the type region, and

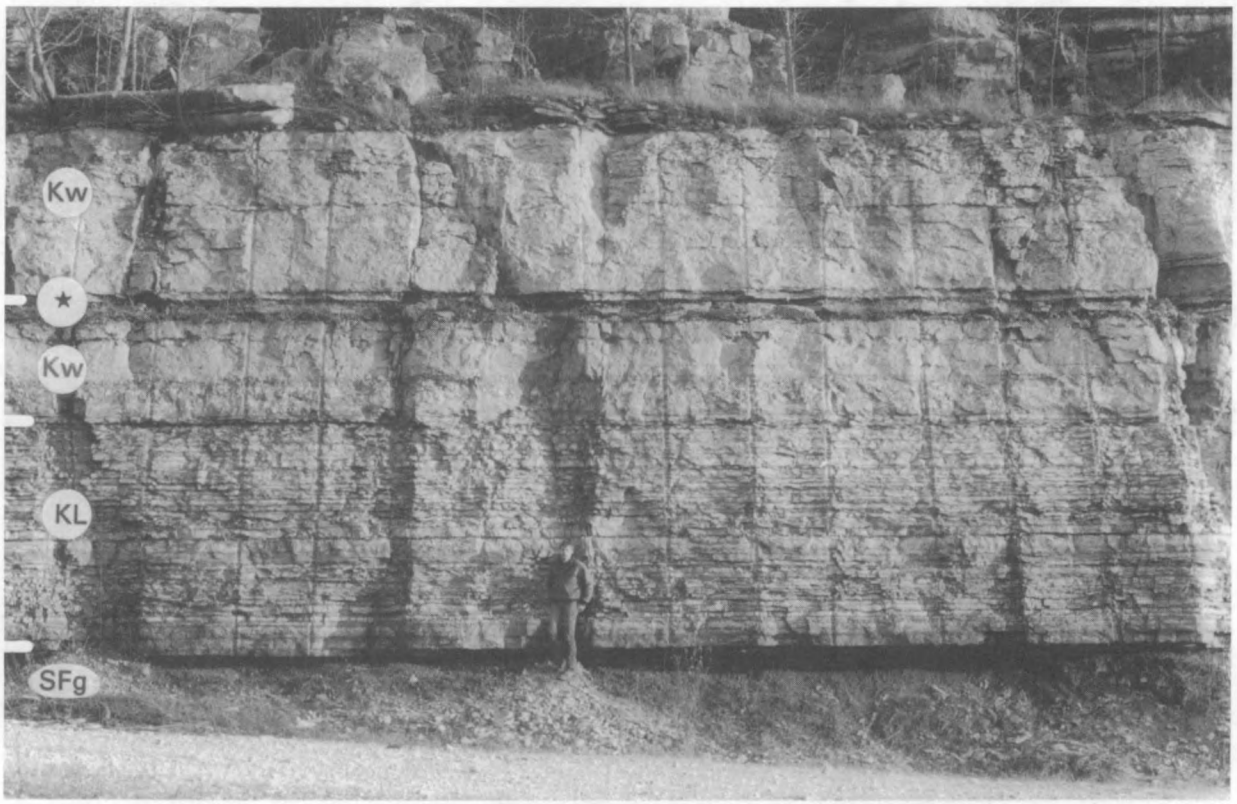


Figure 131. *Upper part of the Decorah Group and* ***Kimmswick Limestone*** *at the type section of the* **House Springs K-bentonite Bed,** *a roadcut on Missouri Highway 30, just north of House Springs, SW¼ SE¼ sec. 33 (projected), T. 42 N., R. 4 E., Jefferson County, Missouri, House Springs 7½' Quadrangle.* (**SFg**) *Glencoe Shale Member of Spechts Ferry Formation;* (**KL**) *Kings Lake Limestone;* (**Kw**) *Kimmswick Limestone;* (*****) *House Springs K-bentonite Bed. Photograph by T.L. Thompson.*

also over all but the northeastern part of Missouri, is all within the pre-"New London" "Dunleith Formation" of Templeton and Willman (fig. 129). The limestones of the "New London Member," and the overlying "Wise Lake Formation" (figs. 124-126), are mostly heavily burrowed fine grainstones to mudstones (fig. 130B). The change in grain size from the medium- to coarse-grained pre-"New London" ("Moredock"), at a thin K-bentonite bed at the base of the "New London," is usually apparent (fig. 125). As stated above, however, this major lithologic change in the Kimmswick of northeastern Missouri is not at the "Dunleith"-"Wise Lake" boundary, but in upper "Dunleith," at the boundary between the "Moredock" and "New London Members." Identification of a "Dunleith"-"Wise Lake" boundary, like formation boundaries within the "Plattin Subgroup" of Templeton and Willman, is nearly or entirely impossible; there is no apparent break that can define such a boundary. A transition occurs toward more fine-grained or lithographic limestone, but it does not constitute a horizon that could define a boundary between formations.

The Kimmswick Limestone of Missouri, therefore, is herein separated into two lithologic units: **1**) a **"lower Kimmswick Limestone,"** a heavily burrowed, bioclastic, coarse grainstone, represented by the type Kimmswick, and the lower part of the Kimmswick throughout its extent; and **2**) an **"upper Kimmswick Limestone,"** a heavily burrowed, bioclastic, fine to medium grainstone to mudstone, that overlies the coarse-grained "lower Kimmswick" in northeastern Missouri. In many places the "upper Kimmswick" appears very similar to the Plattin Limestone; however, the size of the burrows is generally larger in the "upper Kimmswick."

Both "upper" and "lower Kimmswick" weather to a heavily pitted surface (fig. 130). On fresh exposures filled burrows in the Kimmswick are not always apparent; they are usually much larger in diameter than those in the Plattin Limestone. The "lower Kimmswick" is very similar to, and could be mistaken for, the widespread Early Mississippian Burlington Limestone. They look almost identical on fresh surfaces; they can be distinguished by the burrowing in the Kimmswick, the nature of weathered surfaces, their fossil contents, and their stratigraphic positions (the formations above and below them).

In the type area and in east-central and southeastern Missouri a prominent K-bentonite bed occurs approximately 1 m above the base of the Kimmswick; Kolata et al. (1986, p. 23) named it the **House Springs K-bentonite Bed**, from a roadcut on Highway 30, just north of the town of House Springs, in Jefferson County, Missouri (fig. 131). This same bed is well exposed in roadcuts on Interstate Highways 44 and 55, in eastern and southeastern Missouri (figs. 108 and 123).

Willman and Kolata (1978, p. 46) described the fauna typical of Kimmswick strata in northern Illinois:

> "Fossils occur throughout the Dunleith Formation, but they are better preserved and more conspicuous in the lower shaly beds, which include tha Buckhorn and St. James Members. The Buckhorn, St. James, and Beecher Members are characterized by an abundance of the orthid brachiopod *Dalmanella rogata* (Sardeson). The orthid *Glyptorthis bellarugosa* (Conrad) is locally abundant in the Buckhorn. Abundant trepostome bryozoans are often present in the green shale partings on bedding planes. The trepostome *Prasopora* is particularly abundant near the top of the St. James Member in northwestern Illinois...but is rarely present in the relatively purer equivalents to the south and east. Bedding planes in the St. James Member and overlying Dunleith units are often covered with large stemlike trace fossils referable to *Palaeophycus*.
>
> "*Sowerbyella punctorstriata* (Mather) and to a lesser extent *Dalmanella rogata* (Sardeson) are common in the Eagle Point Member.
>
> "*Receptaculites oweni* Hall occurs sporadically throughout the Dunleith and overlying Wise Lake strata. Specimens are abundant in the Fairplay (Lower *Receptaculites* Zone), Rivoli and lower part of the Sherwood Members (Middle *Receptaculites* Zone), and the lower part of the Stewartville Member (Upper *Receptaculites* Zone) of the Wise Lake Formation."

They added (p. 126),

> "The Stewartville Member was called the *Maclurea* bed in early Minnesota reports and is characterized by a gastropod-cephalopod fauna. The Sinsinawa lacks the Stewartville cephalopod fauna as well as the gastropods *Lophospira angustina* Billings, *Maclurites cuneata* (Whitfield), and *Maclurites subrotunda* (Whitfield) but contains all other reported Stewartville species, generally in a similar degree of abundance."

Sweet et al. (1975, p.11-12) defined the time-stratigraphic succession of late "Middle Ordovician" (Mohawkian) and early "Late Ordovician" (Cincinnatian) strata in Missouri (fig. 132), and determined that the facies relationship of upper Trenton-Edenian strata, previously defined by Sweet and Bergstrom (1971), indicated an early Cincinnatian age for uppermost Kimmswick strata in northeastern Missouri.

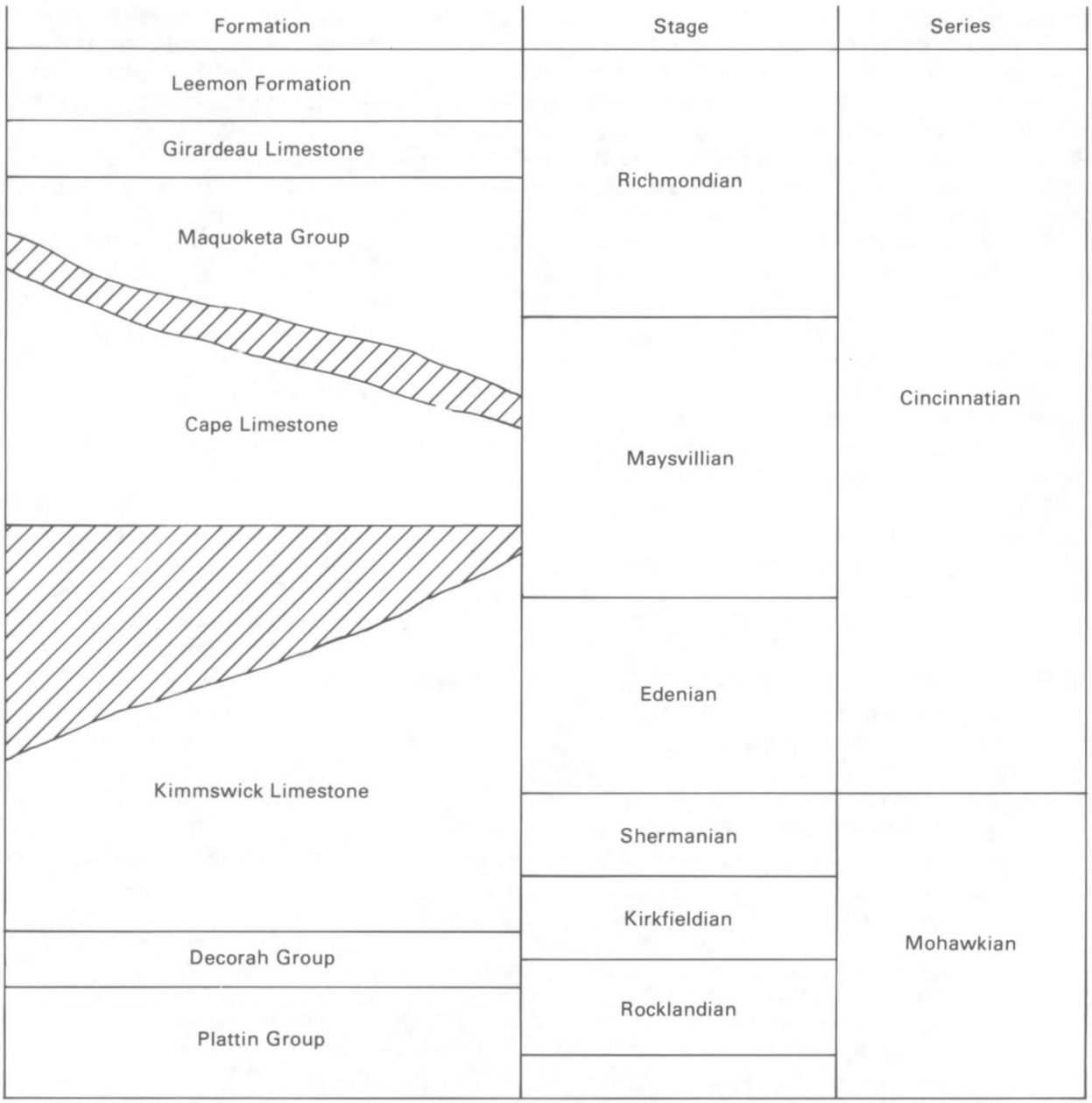


Figure 132. *Chart of formations across the Middle - Upper Ordovician boundary in the Missouri-Arkansas region. After Sweet and Bergström (1976).*

Kimmswick rocks in Missouri, therefore, represent the **Kirkfieldian** and **Shermanian Stages of the Mohawkian Series**, and the lower part of the **Edenian Stage of the Cincinnatian Series** ("McCune limestone"). Ross et al. (1982) also regarded uppermost Kimmswick beds as Cincinnatian in age.

Templeton and Willman (1963, p. 117) indicated that upper Kimmswick strata in northeastern Missouri (their New London Member of the Dunleith Formation) were equivalent in age to the **Cobourg Formation** in the Standard Section of New York. Willman and Kolata (1978, p. 47) concluded that the Dunleith (and therefore the Kimmswick of Missouri) is equivalent to the **Cummingsville** and **Prosser Formations** of

Minnesota, the middle part of the **Viola** of Oklahoma and Kansas, the **Lexington Limestone** of Kentucky, and the lower **Bigby-Cannon** of Tennessee. In addition, it is a correlative of the **Hull**, **Shoreham**, and **Denmark Formations of the Trenton Group** in New York.

The Kimmswick Limestone, quarried throughout its outcrop region in eastern Missouri, like the underlying Plattin Limestone, is a valuable resource for production of cement and limestone aggregate. In Missouri the Kimmswick Limestone ranges from 50 to over 275 ft thick, thickest in the subsurface of northwestern Missouri (fig. 133). Offield and Pohn (1979) identified small patches of Kimmswick Limestone in the "depressed ring zone" surrounding the Decaturville impact structure in Laclede and Camden counties, central Missouri, identified (p. 9) "...with reasonable certainty on the basis of fossil content..." (brachiopods and conodonts).

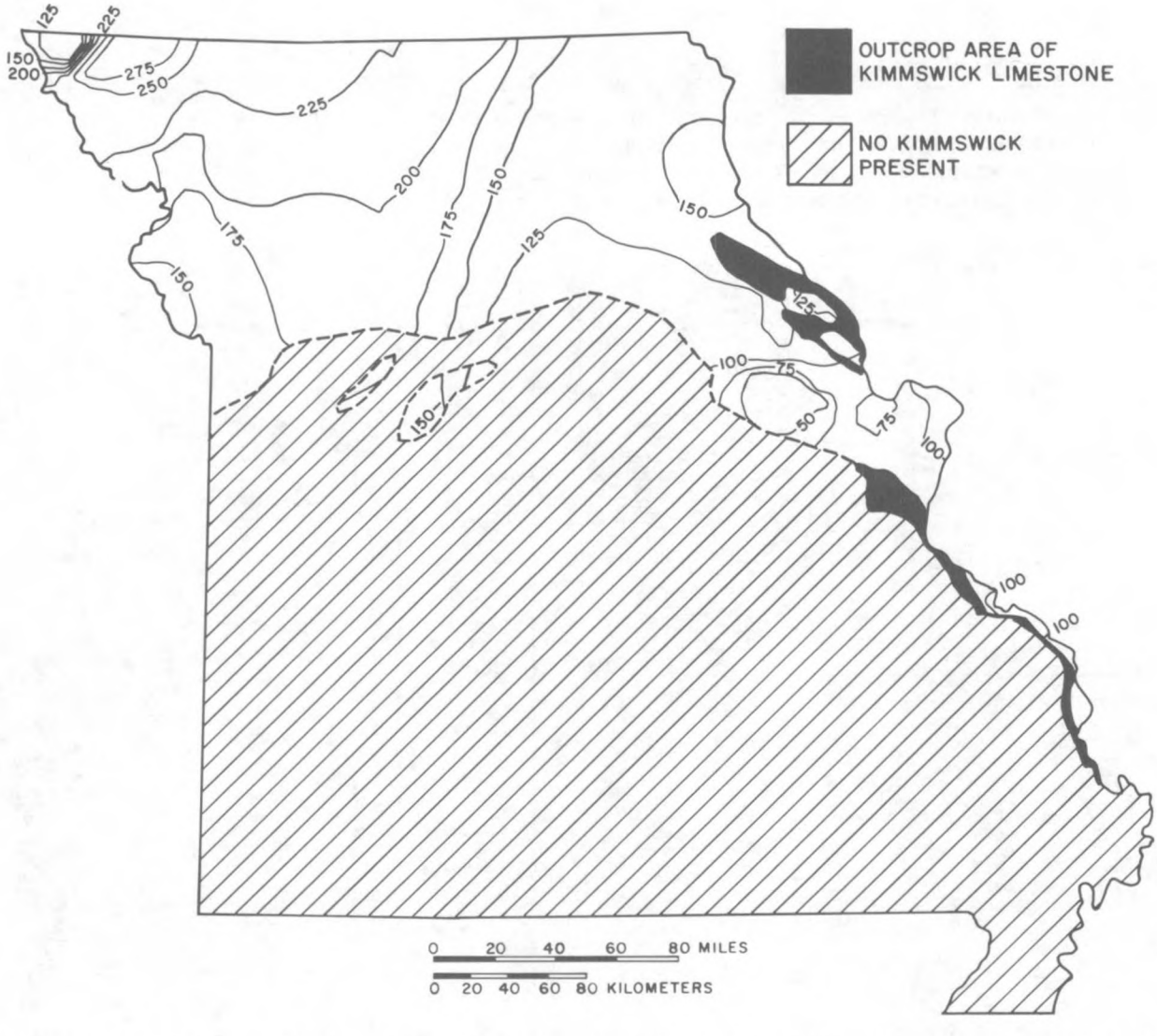


Figure 133. *Isopach map, distribution, and areas of outcrop of the* **Kimmswick Limestone** *in Missouri. Isopach interval is 25 ft.*

CINCINNATIAN SERIES

Meek and Worthen, 1865

Original description -- Gudstadt (1958, p. 519) stated, "The name Cincinnati group was first proposed by Meek and Worthen (1865, p. 155) to replace the name Hudson River group which had been used up to that time in the Cincinnati arch area. They believed that the rocks exposed near Cincinnati are younger than the type Hudson River group, a contention which was not actually accepted by most geologists until Ruedemann (1901, 1904, 1908, 1909, 1912) showed it to be the case. The first subdivision of the Cincinnati group was made by Orton (1873, p. 370-71) who named, in ascending order, the Point Pleasant beds, River Quarry beds, Eden shales, Hill Quarry beds, and Lebanon beds. The first two units are now included in the Trenton group; the last three are roughly the equivalents of the Eden, Maysville, and Richmond 'groups,' as used today."

Type section -- Region about Cincinnati, Ohio.

Remarks -- Cincinnatian rocks in Missouri (figs. 134 and 135) represent all four stages of the Series:

Hirnantian Stage (Leemon Formation, Noix Limestone, Cyrene Formation)
Richmondian Stage (Maquoketa Formation)
Maysvillian Stage (Cape Limestone and lower Maquoketa strata)
Edenian Stage (uppermost Kimmswick)

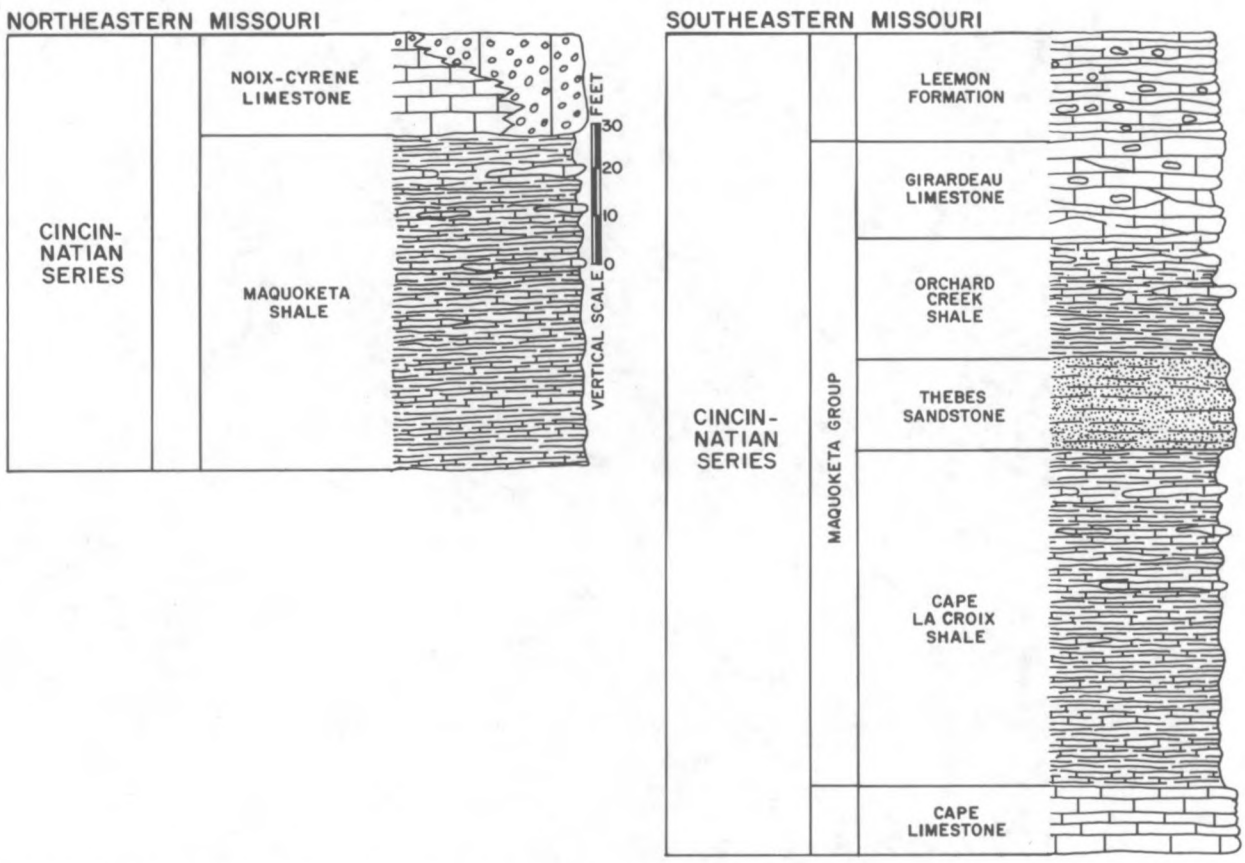


Figure 134. *Generalized columnar section of formations of the* **Cincinnatian Series** *in northeastern and southeastern Missouri.*

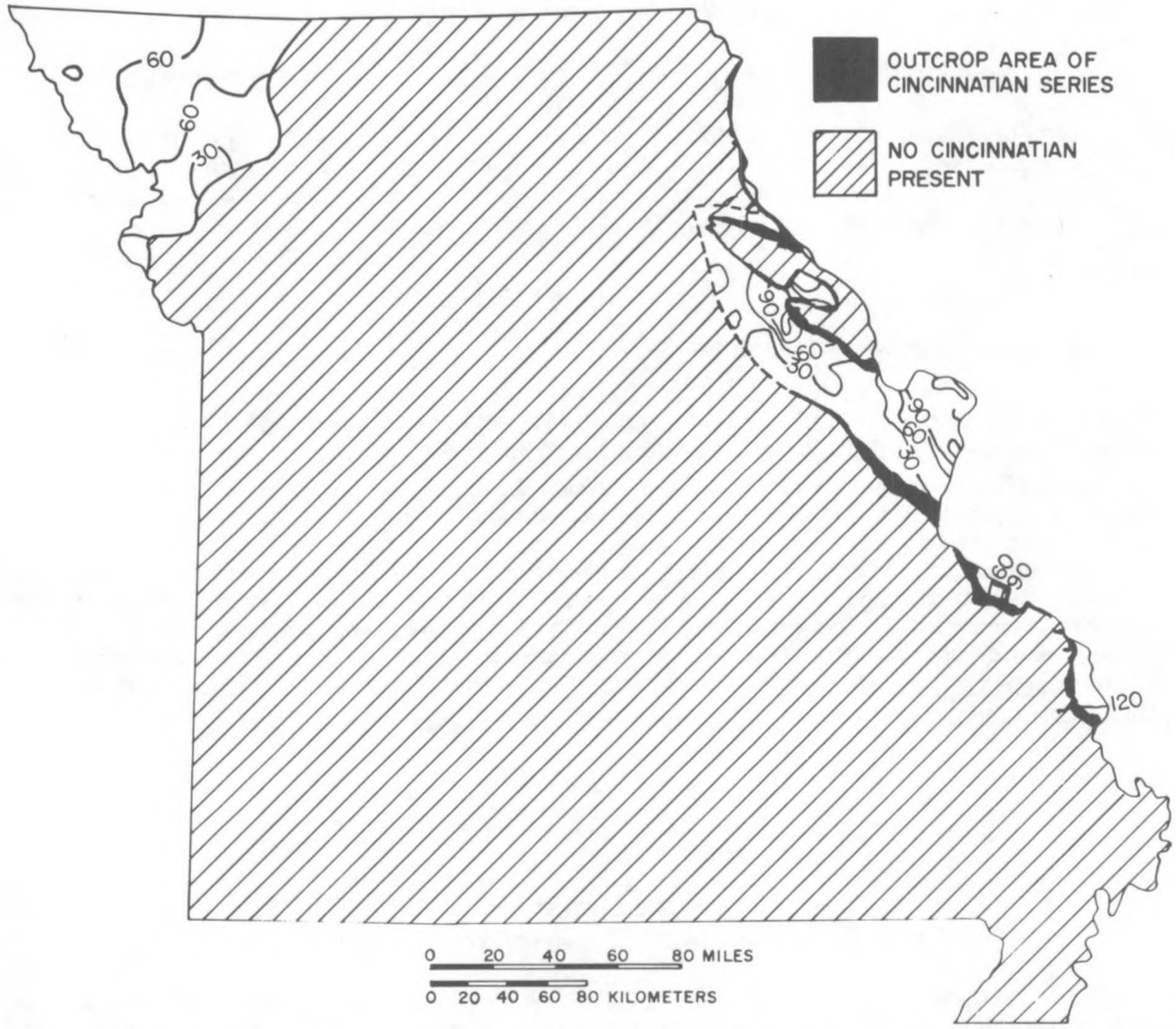


Figure 135. *Isopach map, distribution, and areas of outcrop of rocks of the* **Cincinnatian Series** *in Missouri. Isopach interval is 30 ft.*

Amsden (1974, 1986) identified the uppermost Late Ordovician rocks exposed in southeastern and northeastern Missouri (also described by Satterfield, 1971, and Thompson and Satterfield, 1975) as correlating with the **Hirnantian Stage** (see fig. 2), making them younger than previously described uppermost Cincinnatian (Richmondian) formations in the state.

The Cape Limestone (southeastern Missouri) and Maquoketa Shale (eastern and northeastern Missouri) lie unconformably on the eroded surface of the Late Middle Ordovician (Mohawkian Series; eastern and southeastern Missouri) to Early Upper Ordovician (Edenian Series; northeastern Missouri) Kimmswick Limestone. Restricted post-Maquoketa, post-Richmondian rocks occur in northeastern (Noix and Cyrene Limestones) and southeastern (Leemon Formation, Girardeau Limestone) Missouri.

Cincinnatian rocks in Missouri are represented by the following formations:

Northeastern Missouri	Southeastern Missouri
Noix Limestone (Cyrene Limestone)	Leemon Formation
	Maquoketa Group
	Girardeau Limestone
Maquoketa Shale (undifferentiated)	Orchard Creek Shale
	Thebes Sandstone
	Cape La Croix Shale
	Cape Limestone
Kimmswick Limestone ("upper")	

Uppermost Ordovician strata in Missouri, representing the **Hirnantian Stage** (Amsden, 1986), lie unconformably beneath basal Silurian rocks. Amsden (1986, p. 29) stated,

> "In the southern area, near Thebes [Illinois], the Sexton Creek [basal Silurian formation] rests on the Edgewood [Leemon Formation], whereas across the Mississippi River at the city of Cape Girardeau this formation rests directly on the Girardeau Limestone...
>
> "The Ordovician-Silurian boundary in the southern area is drawn at the unconformable contact of the Sexton Creek with the Edgewood Group [Leemon Formation]. This brings the Late Ordovician (Hirnantian) Leemon Formation of the Edgewood Group into direct contact with the overlying Sexton Creek. However, in the northern outcrop area the upper part of the Edgewood Group (Bryant Knob Formation and the upper part of the Bowling Green Dolomite) is assigned an Early Silurian age (stage unspecified)."

The Sexton Creek lies on the Early Silurian Bowling Green Dolomite.

Cape Limestone

Gudstadt, 1958; Templeton and Willman, 1963

Original description -- (Gudstadt, 1958, p. 523-524) "Shideler (1937, p. 367-368) also examined existing correlations and concluded, on the basis of faunal and lithologic differences, that the 'Fernvale' of Missouri and southwestern Illinois is of a different age than the type Fernvale of Tennessee. He correlated the type Fernvale with the Elkhorn 'formation' of the Richmond 'group' of the Cincinnatian Series. The Missouri 'Fernvale' he renamed Ada limestone, and stated that it was to be tentatively correlated with the Maquoketa formation, although as he said, it might not even be Richmondian in age...

"Templeton and Willman (1953, unpub.) reported that the name Ada limestone was pre-empted and proposed the name Cape limestone from Cape Girardeau, Missouri. Templeton and Willman believed that their Cape limestone is older than any Cincinnatian beds in the Cincinnati type area. The name Cape limestone is proposed in a recent paper (Templeton and Willman, in press), and the name is used in this report."

As described by Templeton and Willman (1963, p. 135), "The Cape Limestone consists of limestone which, except for scattered, thin, argillaceous laminae, is pure, light gray weathering brownish gray to reddish gray, coarse grained, calcarenitic, very fossiliferous, and medium to thick bedded. It is similar in general character to the underlying Kimmswick Limestone but is distinguished by thinner bedding and argillaceous laminae."

Type section -- Sweet et al. (1975, p. 6) located the type section of the Cape Limestone in a "roadcut on Main Street, 100 yards north of junction of Main and Broadway streets in the city of Cape Girardeau, Cape Girardeau County, Missouri; center west half NW¼ NE¼ sec. 5, T. 30 N., R. 14 E. (projected), Cape Girardeau 7.5-minute quadrangle (MGS locality 1321-64)." At the type section approximately 8 ft of Cape Limestone is exposed (figs. 136-138).

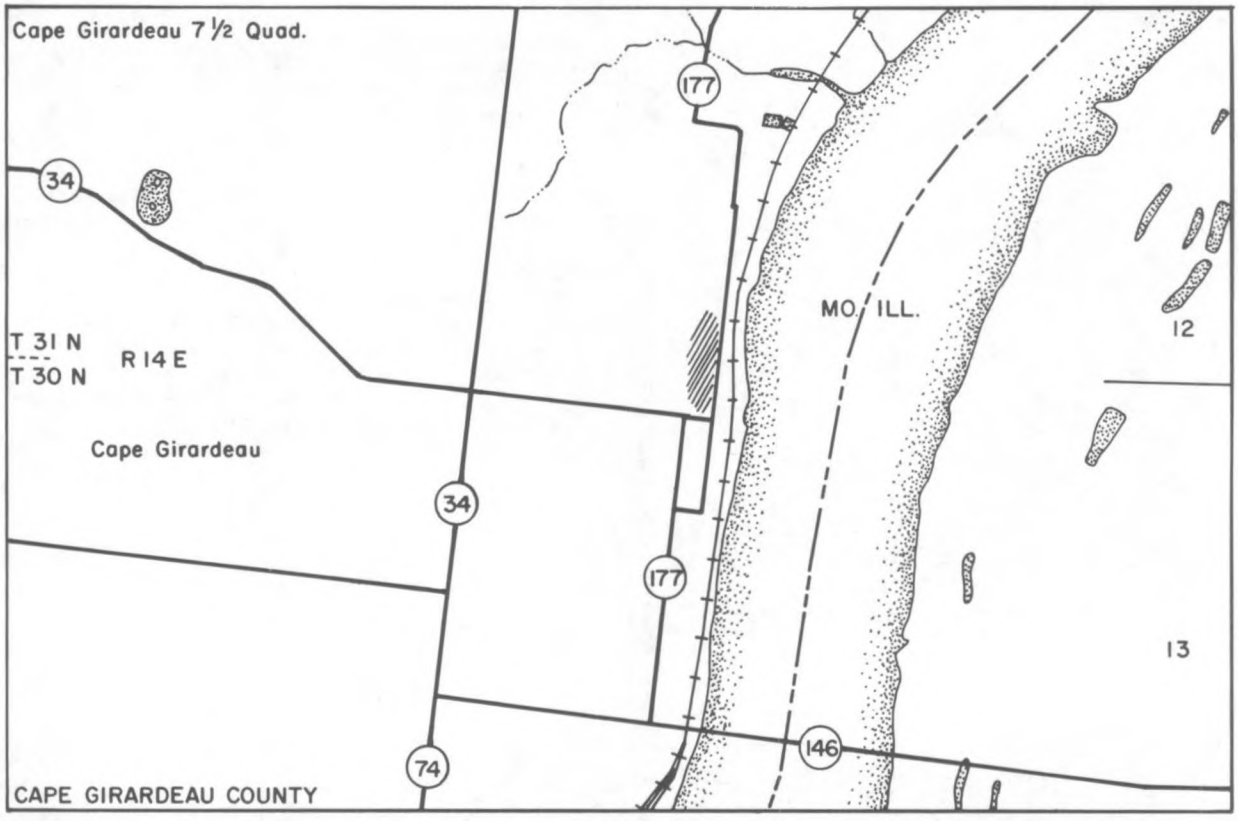


Figure 136. *Part of the Cape Girardeau 7½' Quadrangle, showing location of the type section of the* **Cape Limestone,** *NW¼ NE¼ sec. 5, T. 30 N., R. 14 E., Cape Girardeau County, southeastern Missouri.*

Reference sections -- The Cape Limestone is well exposed at several sections in southeastern and eastern Missouri where it is much thinner than in the type section. Three such sections (fig. 139) were studied by Sweet et al. (1975):

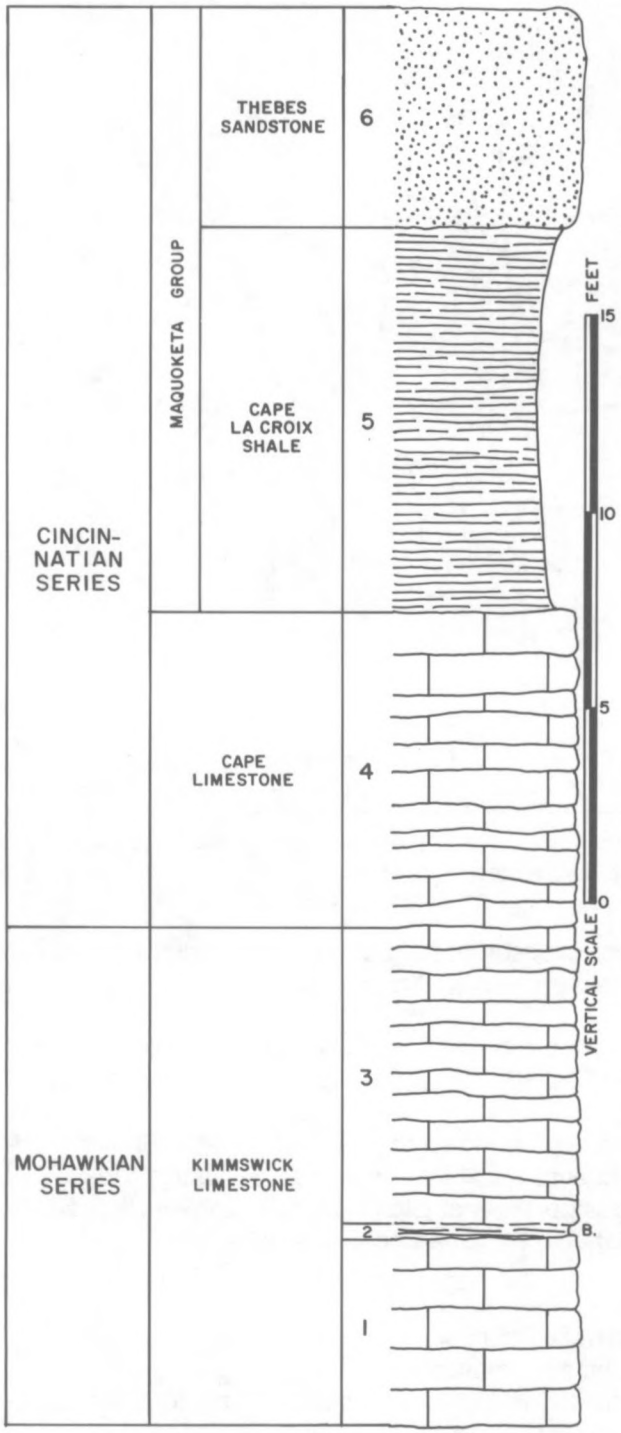
1. **Sunnyside section**: railroad cut along the west side of the Mississippi River Valley immediately north of small community of Sunnyside, NE¼ sec. 19, T. 42 N., R. 6 E., Jefferson County, Missouri, Valmeyer 7½' Quadrangle (fig. 139A).

2. **Barnhart section**: roadcut on I-55, 0.75 mi north of Barnhart interchange (Hwy. M), SE¼ sec. 19, T. 42 N., R. 5 E., Jefferson County, Missouri, Herculaneum 7½' Quadrangle (figs. 122 and 139B).

3. **Westlake South quarry**: in west bank of Mississippi River at Glen Park, NW¼ NW¼ NE¼ sec. 5, T. 41 N., R. 4 E., Jefferson County, Missouri, Herculaneum 7½' Quadrangle (fig. 139C).

History of nomenclature

1904	Ulrich	"Fernville Richmond fauna"
1907	Weller	Richmond limestone
1909	Savage	Fernvale limestone (proposed for limestone in Missouri the same age as the Fernvale of Tennessee)
1911	Ulrich	Fernvale (southeastern Missouri)
1921	Dake	Fernvale (Richmond) limestone
1936	Ireland	Ada limestone (replaced "Fernvale limestone")
1944	Branson	Fernvale formation
1947	Taylor	"Fernvale" limestone
1954	Twenhofel et al.	"Fernvale" limestone
1955	Gealy	La Croix Limestone
1958	**Gudstadt**	**Cape limestone** ("Ada" preempted)
		"Fernvale" limestone



ORDOVICIAN SYSTEM - CINCINNATIAN SERIES
***MAQUOKETA GROUP* (15 ft+)**
Thebes Sandstone (5-6 ft)
6. Sandstone, brown, fine-grained. (5-6 ft)
Cape La Croix Shale (8-12 ft)
5. Shale, brown to gray, weathered. (8-12 ft)
Cape Limestone (8 ft)
4. Limestone, gray to dark-gray, calcarenitic; upper 2 ft 2 in. massive; lower 6 ft nodular, irregularly bedded; very fossiliferous, crinoid fragments. (8 ft 2 in.)

MOHAWKIAN SERIES
Kimmswick Limestone (13 ft)
3. Limestone, gray to dark-gray, finely to medium-grained calcarenite, slightly argillaceous; irregular, nodular bedding. (8 ft)
2. K-bentonite, light-gray to gray. (2 in.)
1. Limestone, light-gray, medium-grained calcarenite, massive; stylolitic; fossiliferous, crinoidal. (5 ft)

Figure 137. Type section of the **Cape Limestone,** *NW¼ NE¼ sec. 5, T. 30 N., R. 14 E., Cape Girardeau County, southeastern Missouri (fig. 136). Adapted from description by Sweet et al. (1975).*

Figure 138. *Type section of the* **Cape Limestone,** *NW¼ NE¼ sec. 5, T. 30 N., R. 14 E., Cape Girardeau County, southeastern Missouri (figs. 136 and 137).* **(Kw)** *Kimmswick Limestone;* **(Ca)** *Cape Limestone. Photograph by T.L. Thompson.*

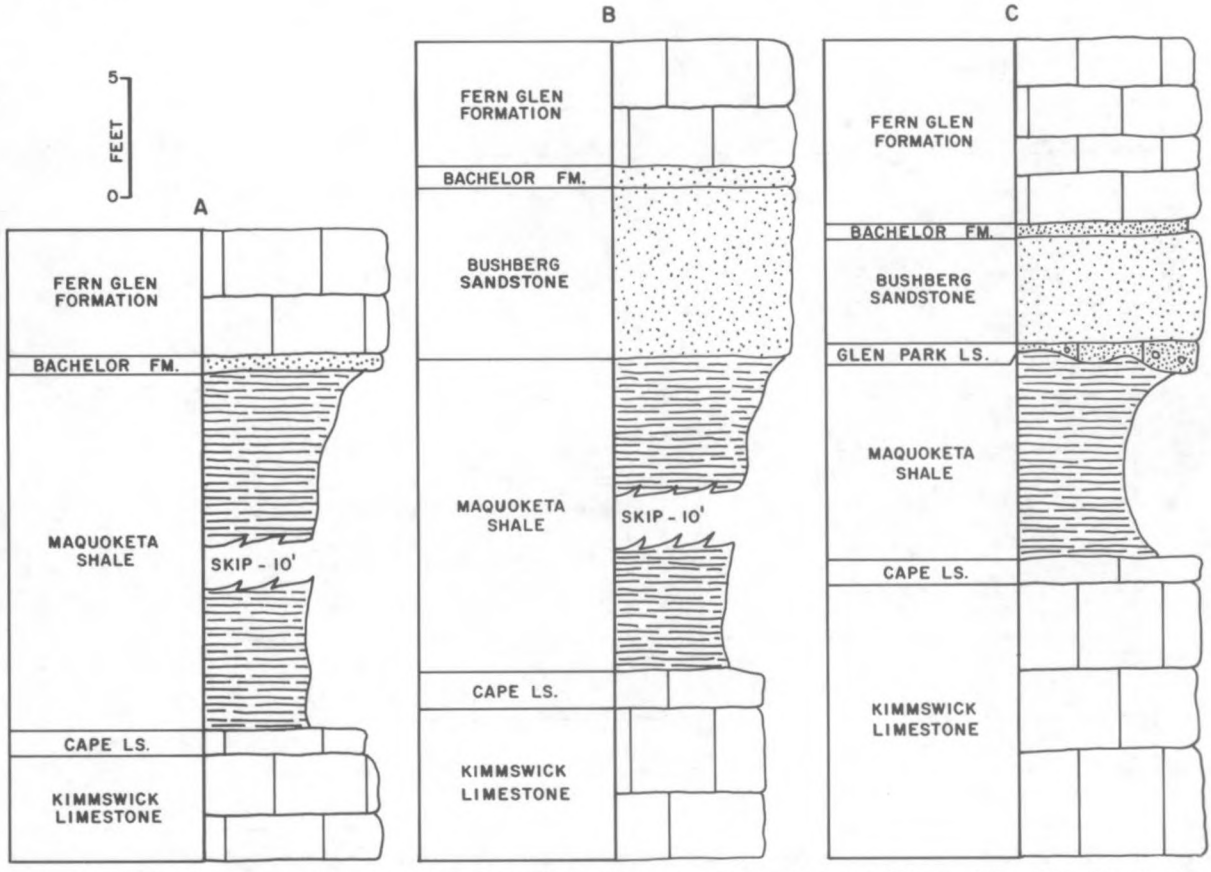


Figure 139. *Three exposures of the* **Cape Limestone** *in southeastern and east-central Missouri (fig. 122). Adapted from Sweet et al. (1975).*

1960	Pulse and Sweet	Cape limestone
1961	Martin et al.(a)	Cape formation
1963	Templeton and Willman	Cape Limestone of Maquoketa Group
1975	Sweet et al.	Cape Limestone
1979	Amsden	Welling Formation (in Oklahoma)
	Sable	Fernvale Limestone
1982	Thompson	Cape Limestone
	Ross et al.	Cape Limestone ("= Dubuque Limestone in Iowa, northern Illinois, and southeast Minnesota")
1987	Thompson	Cape Limestone
1991	**Thompson (present report)**	**Cape Limestone**

Remarks -- At the type section, the Cape Limestone is approximately 8 ft (2.5 m) thick. At nearly all other exposures of the Cape Limestone in Missouri it consists of a single limestone bed at the top of the much thicker Kimmswick Limestone (fig. 139); the Cape is usually less than 1 ft thick. The contact with the underlying Kimmswick Limestone has been described as "welded." No bedding plane separates Kimmswick from Cape; the contact appears to be within a bed. The Cape, however, can be distinguished, because it is finer grained, more fossiliferous, and darker than the Kimmswick. In addition, the Cape is faunally disconformable with respect to the Kimmswick.

The Cape Limestone is Middle Cincinnatian (Maysvillian) according to Sweet et al. (1975), although Willman and Buschbach (1975) considered the Cape Limestone to be Edenian. In southeastern Missouri and east-central Missouri, where the Cape Limestone occurs, the Kimmswick Limestone is Late Mohawkian (Kirkfieldian/Shermanian). The Richmondian Maquoketa Shale (dated Edenian-Richmondian by Willman and Buschbach, 1975) disconformably overlies the Cape Limestone.

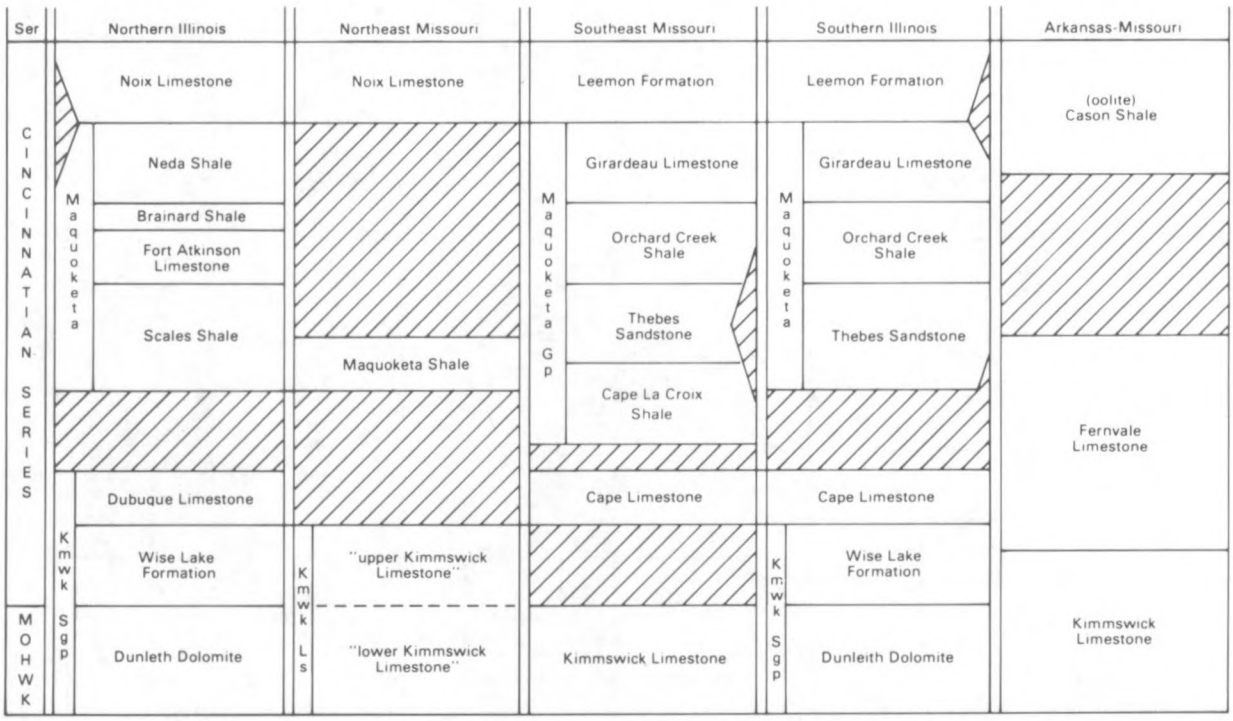


Figure 140. *Correlation chart of upper Mohawkian and Cincinnatian formations in Missouri, Arkansas, and Illinois. Adapted from Ross et al. (1982).*

The Cape Limestone is correlative with the **Dubuque Formation** of the Kimmswick Subgroup in Iowa, Minnesota, and northern Illinois (fig. 140). In this respect, although disconformable on the Kimmswick in southeastern Missouri, it is more closely related depositionally to the Kimmswick Limestone than to the overlying Maquoketa Group, which is disconformable on the Cape Limestone.

Martin et al. (1961a, p. 30) stated,

> "Fossils, particularly brachiopods and barrel-shaped crinoid columnals, are abundant but poorly preserved. The brachiopod *Lepidocyclus* is commonly present in the formation in Missouri...
>
> "In its outcrop area in southeastern Missouri, the formation ranges from a maximum thickness of about 15 feet in Cape Girardeau County to less than a foot in Ste. Genevieve and Jefferson Counties. In the subsurface of northwestern Missouri, a dolomite questionably identified as the Cape formation is 10 to 40 feet thick."

In a detailed study of the Cape Limestone of eastern Missouri, Sweet et al. (1975, p. 27) concluded,

> "In the area of outcrop of the Cape Limestone, the Cape is underlain by the Kimmswick Formation, of late Kirkfieldian-early Shermanian age, and overlain by the Maquoketa Formation of probable Richmondian age. From an analysis of conodont distribution, we conclude that the oldest strata of the Cape Limestone are those in the lower half of its type section, where an early to mid-Maysvillian age is possible (strata with *Belodina compressa*). The Cape is probably of somewhat later Maysvillian age in the other sections we have studied, which lack *Belodina* entirely or yield only *B. inclinata*. The upper half of the type Cape, and all of the formation that remains in the other sections we have studied, may be slightly **younger than the Dubuque Formation** of the Upper Mississippi Valley, but the lower half of the type Cape is a likely **equivalent of the upper Galena Group** (*i. e.*, upper-most **Stewartville** and **Dubuque Formations**). We agree with Templeton and Willman (1963) in their correlation of the latter strata with late Cobourgian rocks in New York and Ontario, but we regard them and the Cape Limestone as mid-Cincinnatian deposits rather than as late Champlainian rocks." [bold type mine]

Maquoketa Shale

White, 1870

Maquoketa Group

Gudstadt, 1958

Original description -- (White, 1870; *from* Ladd, 1928, p. 323) "The whole formation is largely composed of bluish and brownish shales which weather into a tenacious clay upon the surface, and the soil derived from it is usually stiff and clayey. The shales are sometimes slightly arenaceous, and sometimes calcareous bands compose a considerable part of its bulk. The latter is the case at the typical localities on the Little Maquoketa river about twelve miles westward from Dubuque."

Type section -- The Maquoketa Shale was named for exposures in the Little Maquoketa River Valley, Dubuque County, Iowa. Ladd (1928, p. 330) stated, "Southeast Area: This province includes the exposures along Little Maquoketa river, in Dubuque county, designated by White the type exposures of the Maquoketa. In some respects White's choice was an unfortunate one for some of the outcrops which he studied are extraordinary in many ways and are duplicated nowhere else. The section shows very unusual lithologic characters and bears many unique fossiliferous beds. It may be added also that only the lower part of the formation is well exposed. However, this Little Maquoketa Valley exposes the type section, which shows what is after all the chief characteristic of the southeast phase--namely an almost total absence of indurated rocks. Aside from a few feet of thin limestone layers near the top and an even thinner zone of indurated beds at the base the Maquoketa in this province is made up of green or blue shale throughout. In section 29, township 86 north, range 5 east, practically the entire thickness of 190 feet is exposed."

Reference sections -- An excellent reference section to the Maquoketa Shale of east-central Missouri is in a roadcut on I-55, in eastern Jefferson County, SE¼ sec. 19, T. 42 N., R. 6 E., Herculaneum 7½' Quadrangle (figs. 122 and 141). This section has been described by Sweet et al. (1975), Thompson (1975, 1986), and Thacker and Satterfield (1977).

Reference sections for the Maquoketa Group in southeastern Missouri are included in the discussions of the four formations assigned to the Maquoketa Group in that region.

History of nomenclature

1855	Swallow	Hudson River Group
1870	**White**	**Maquoketa shales** (in Iowa)
1874	Broadhead	Cincinnati group
1891	Rowley	Hudson River shales
1894	Winslow	Hudson River group
1895	Keyes	Hudson shales
1897	Sardeson	Maquoketa series
1898	Keyes	Buffalo shale of Hudson River group
	Marbut	Hudson River group
1900	Gallaher	HudsonRiver beds (Lorraine shale)
1904	Buckley and Buehler	Hudson River or Thebes
	Ulrich	Thebes formation (3 members)
1907	Weller	Maquoketa shale
1908	Savage	Richmond - Maquoketa beds
1916	Rowley	Buffalo shale (Maquoketa or Richmond)
1921	Dake	Maquoketa shale

Figure 141. **Maquoketa Shale** *and overlying Mississippian formations in a roadcut on I-55 north of the Barnhart (Highway M) interchange, SW¼ SE¼ sec. 19, T. 42 N., R. 6 E., Herculaneum 7½' Quadrangle, Jefferson County, Missouri (figs. 122 and 139B).* (**Mq**) *Maquoketa Shale;* (**Bb**) *Bushberg Sandstone;* (**Fg**) *Fern Glen Formation. Photograph by T.L. Thompson.*

1928	Weller and St. Clair	Thebes - Maquoketa formation
1933	Branson and Mehl (a)	Maquoketa-Thebes
1939	Grohskopf et al.	Maquoketa ("Sylvan") formation
	McQueen	Thebes
		Maquoketa
1941	Dott	Maquoketa shale
		Orchard Creek shale
		Thebes sandstone
1944	Branson	Maquoketa formation
1953	Rhodes	"Maquoketa - Thebes formation of Missouri"
1958	**Gudstadt**	**Maquoketa group**
1960	Pulse and Sweet	Orchard Creek shale ("Maquoketa")
1961	Martin et al. (a)	Maquoketa formation (northeastern Missouri)
		Orchard Creek (?) formation (southeastern Missouri)
		Thebes formation (southeastern Missouri)
		Maquoketa formation (southeastern Missouri)
1963	**Templeton and Willman**	**Maquoketa Group** (upper part; includes Cape Limestone in Illinois)
		Neda Formation
		Brainard Formation
		Fort Atkinson Formation
		Scales Formation
1966	Echols and Levin	Maquoketa Shale (northeastern Missouri)
1971	Berry and Marshall	Maquoketa Formation (east-central Missouri)
1975	Thompson and Satterfield	(northeastern Missouri)
		Maquoketa Shale
		(southeastern Missouri)
		Girardeau Limestone
		Orchard Creek Shale
		Thebes Sandstone
		Maquoketa Shale
1982	Thompson	Maquoketa Shale (northeastern Missouri)
1983	Kolata and Graese	Maquoketa Group (northern Illinois)
		Neda Formation
		Brainard Formation
		Fort Atkinson Formation
		Scales Formation
1986	Brezinski	Maquoketa Group (northeastern Mo.; "= Scales Formation of the Maquoketa Group of northern Illinois and eastern Iowa")
1991	**Thompson (present report)**	**Maquoketa Shale (northeastern Missouri)**
		Maquoketa Group (southeastern Missouri)
		Girardeau Limestone
		Orchard Creek Shale
		Thebes Sandstone
		Cape La Croix Shale (new)

Remarks -- Maquoketa strata are exposed in the southeastern, east-central, and northeastern region of Missouri (fig. 142). Concerning the latter two, Martin et al. (1961a, p. 30) stated,

> "The Maquoketa formation is typically a thinly laminated, silty, calcareous or dolomitic shale which locally contains nodular and shaly lenses of limestone. The color of the shale ranges through various shades of dull green, dark gray, and brown. The limestone is commonly light brown or gray. The formation is locally fossiliferous, especially where the shale is calcareous and thin beds of limestone are present. Mollusks,

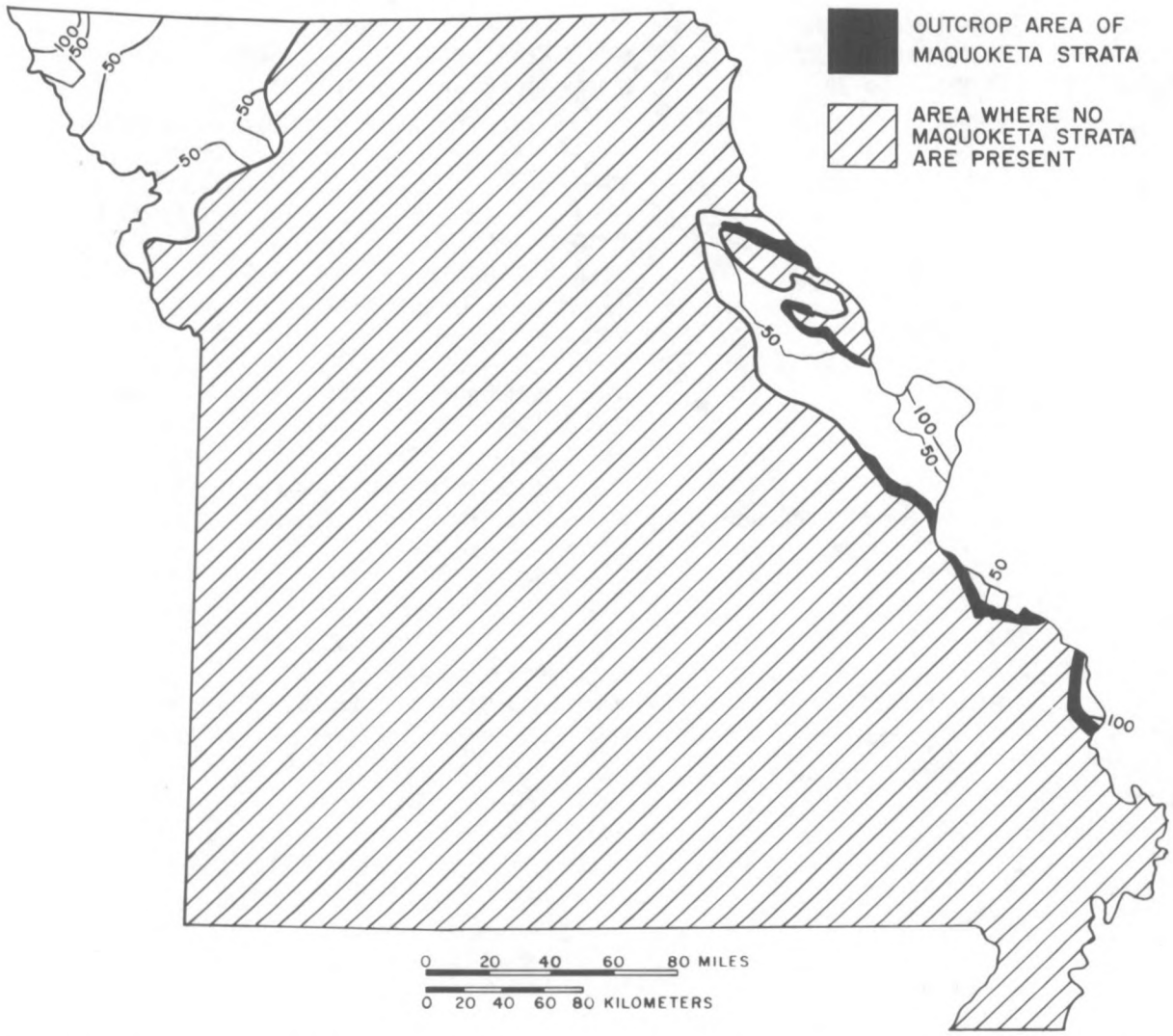


Figure 142. *Isopach map, distribution, and areas of outcrop of the* **Maquoketa Group** *in Missouri. Isopach interval is 50 ft.*

corals, and brachiopods are the most common fossils. Graptolites are commonly regarded as an index of the Maquoketa in subsurface work. Quartz sand grains and quartzose sandstone lentils are present locally in the upper part of the formation."

In southeastern Missouri, the Maquoketa sequence (Maquoketa Group) consists of four distinct lithologic units:

Maquoketa Group
- Girardeau Limestone
- Orchard Creek Shale
- Thebes Sandstone
- Cape La Croix Shale (new)

The **Thebes Sandstone** occurs in the southeastern Missouri counties of northern Scott, Cape Girardeau, Perry, and southern Ste. Genevieve. The **Girardeau Limestone** is more restricted, limited to Cape Girardeau and northern Scott counties. In extreme southwestern Illinois, occurrence of the Girardeau and Thebes are similarly restricted (Templeton and Willman, 1963, p. 133).

North of Ste. Genevieve County in Missouri, the Thebes Sandstone disappears, and the **Orchard Creek Shale** merges with the **Cape La Croix Shale** into a single unit, the **Maquoketa Shale**, which extends into

northeastern Missouri. In southeastern Missouri, therefore, the **Maquoketa Group** consists of four formations that merge northward into a single shale through disappearance of the Thebes Sandstone and the Girardeau Limestone.

In northeastern Missouri the **Maquoketa Shale** lies unconformably on the Kimmswick Limestone, which may be as young as Middle Cincinnatian (Templeton and Willman, 1963; Sweet et al., 1975). The Maquoketa is conformably overlain by younger Cincinnatian strata in restricted parts of northeastern (Noix and Cyrene Limestones, Amsden, 1974; Thompson and Satterfield, 1975) and southeastern (Leemon Formation; Thompson and Satterfield, 1975) Missouri, and unconformably overlain by Early Silurian to Early Mississippian (Kinderhookain) rocks at others. At places in northeastern Missouri, where the Hannibal Shale lies on Maquoketa Shale, the contact between the two is often difficult to identify.

In St. Louis County, east-central Missouri, Maquoketa strata lie unconformably on the Kimmswick Limestone, but in and south of Jefferson County they lie unconformably on the Cincinnatian Cape Limestone, which lies on the Kimmswick. The Maquoketa is overlain unconformably by Late Devonian (Glen Park Limestone) or Early Mississippian (Bushberg Sandstone) strata.

Maquoketa fossils are not rare, but good examples are uncommon. Brezinski (1986) described a fauna of the trilobite *Ampyxina bellatula* (Savage) from slabs of dolomitic limestone in Pike County, northeastern Missouri. In the St. Louis region (figs. 122 and 141), Berry and Marshall (1971) collected two Late Ordovician graptolites from the Maquoketa: *Orthograptus truncatus* var. *socialis* (Lapworth), from the stratigraphically lower interval, and *Climacograptus mississippiensis* Ruedemann, from the upper interval. They concluded (p. 255),

> "The presence of Late Ordovician graptolites in the Maquoketa Formation near Barnhart [Missouri] is suggestive of correlation of the rocks bearing them within the span of the upper part of the Maysville and the Richmond and indicates that the Maquoketa exposed there is probably younger than that to the southeast in southern Illinois and adjacent Missouri (Thebes Sandstone and Orchard Creek Shale) and that it is correlative with the upper part of the Maquoketa Formation in Iowa."

If so, the Maquoketa Shale of northeastern Missouri may be equivalent only to the Orchard Creek Shale of southeastern Missouri, and the Maquoketa Group is transgressive (diachronous) from southeastern

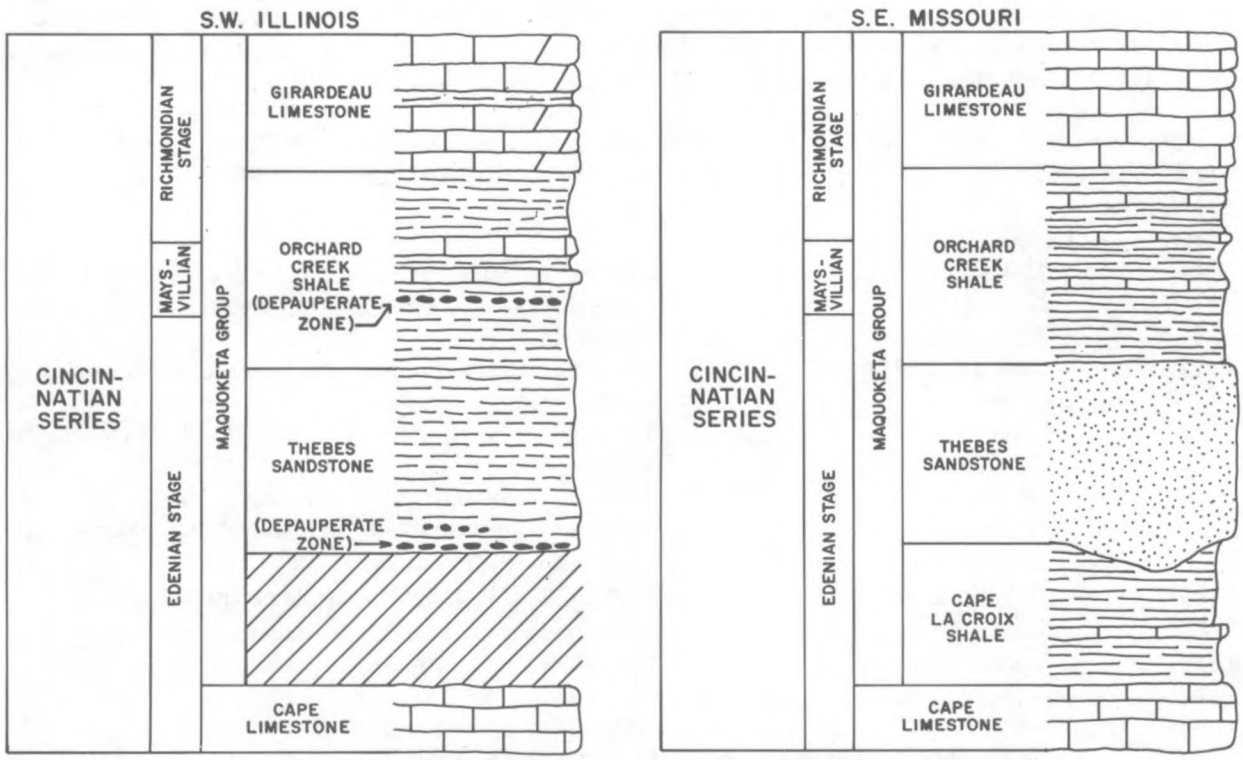


Figure 143. *Comparison of the* **"Maquoketa"** *of Templeton and Willman (1963) to that defined in the present report.*

into northeastern Missouri, a circumstance that would result in the basal beds of the Maquoketa becoming progressively younger in that direction.

In southeastern Missouri the **Cape La Croix Shale** lies unconformably on the Cape Limestone (fig. 137). The **Girardeau Limestone** is overlain disconformably by the Late Cincinnatian Leemon Formation at some places, the Early Silurian Sexton Creek Limestone at others. The Cape La Croix Shale and overlying Thebes Sandstone are separated by a sharp, possibly disconformable, contact, as are the Thebes and overlying Orchard Creek Shale. The Orchard Creek Shale and overlying Girardeau Limestone are distinctly transitional (Sweet et al., 1975); the boundary is defined by a zone in which there is an upward gradational increase in limestone and a decrease in shale.

As described by Martin et al. (1961a, p. 31),

> "The thickness of the Maquoketa in southeastern Missouri ranges from 10 to 60 feet. The thickness of the formation in the Forest City basin of northwestern Missouri ranges from 20 to 70 feet. The average thickness in northeastern Missouri is 100 feet, but it ranges from 30 to 140 feet."

The use of **"Maquoketa Group"** in Missouri is not the same as that proposed by Templeton and Willman (1963) for southwestern Illinois (fig. 143). They included strata much higher (younger) than any included in Missouri, and they did not include the Girardeau Limestone or the lower (Cape La Croix) shale. In Missouri, the gradational nature of the Orchard Creek - Girardeau contact dictates the inclusion of both formations in the Maquoketa Group.

Maquoketa Group

Gudstadt, 1958; Thompson, 1991 (present report)

Cape La Croix Shale

Gealy, 1955; Thompson, 1991 (present report)

Type section -- Gealy (1955, p. 94a), in an unpublished manuscript, described an excellent exposure of about 4 ft of Thebes Sandstone and 18 ft of an unnamed lower shale of the Maquoketa Group, which he named the "Randol shale." This section is herein chosen to serve as the type for the Cape La Croix Shale, and is located in the north-center SW¼ SW¼ SW¼ sec. 13, T. 31 N., R. 13 E., Cape Girardeau County, Missouri, Cape Girardeau 7½' Quadrangle (figs. 144 and 145).

Reference section --An excellent reference section is at the type section of the Cape Limestone, in the city of Cape Girardeau, near the intersection of Broadway and North Main streets (figs. 137and 138).

History of nomenclature

1921	Dake	Thebes sandstone (lower part; recognized lower shale was separate from sandstone above)
1939	McQueen	Maquoketa
1942	Willman and Payne	"lower brown shale member" of Maquoketa formation (lower part)
1945	DuBois	"lower shale zone" of Maquoketa formation (lower part)
1954	Twenhofel et al.	Maquoketa shale (restricted, southeastern Missouri)
1955	Grohskopf	Thebes-Maquoketa formation (lower part)
	Gealy	**Randol shale member of Maquoketa formation** (unpublished manuscript)
1960	Pulse and Sweet	Orchard Creek shale ("Maquoketa"; lower part)
1961	Martin et al. (a)	Maquoketa formation (southeastern Missouri)
1975	Thompson and Satterfield	Maquoketa Shale (restricted)
1977	Thacker and Satterfield	Maquoketa Shale
1982	Thompson	Maquoketa Shale (southeastern Missouri)
1991	**Thompson (present report)**	**Cape La Croix Shale**

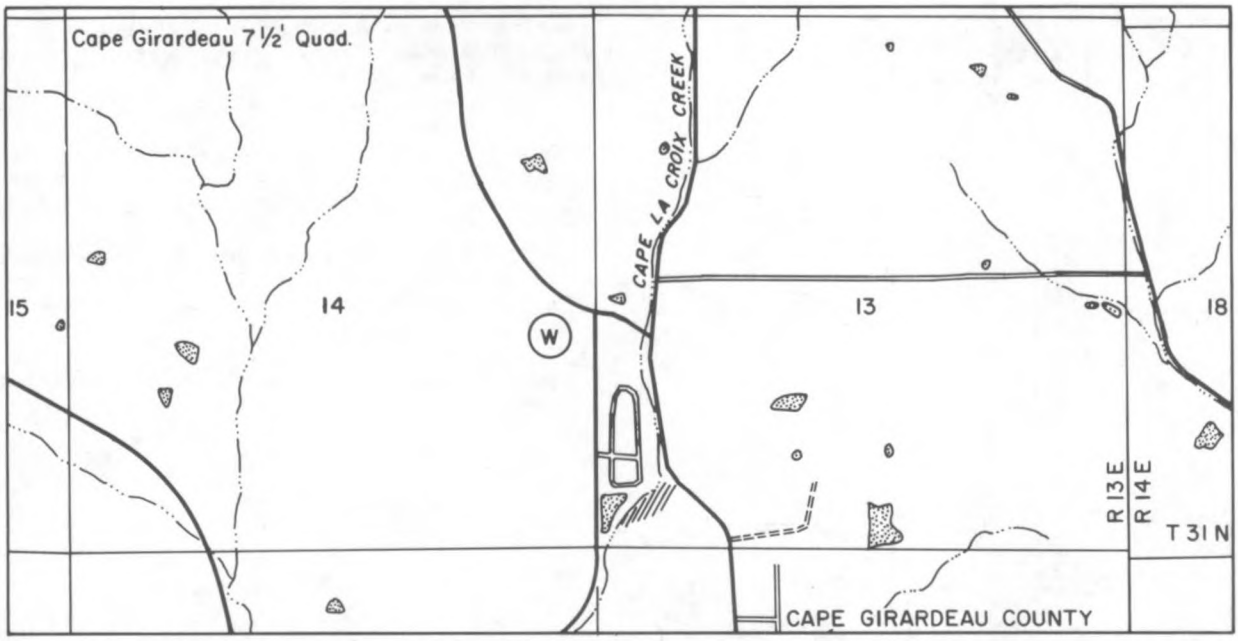


Figure 144. *Part of the Cape Girardeau 7½' Quadrangle showing location of the type section for the* ***Cape La Croix Shale*** *of the Maquoketa Group, SW¼ SW¼ SW¼ sec. 13, T. 31 N., R. 13 E., Cape Girardeau County.*

Remarks -- The Maquoketa Group in southeastern Missouri comprises four formations, the lowest of which has never been formally named. Gealy (1955, p. 95), in an unpublished dissertation, stated,

> "The shale beneath the Thebes sandstone member is here designated the Randol shale member from Randol School which is 1½ miles north-northwest of the type exposure on the east fork of Cape La Croix Creek."

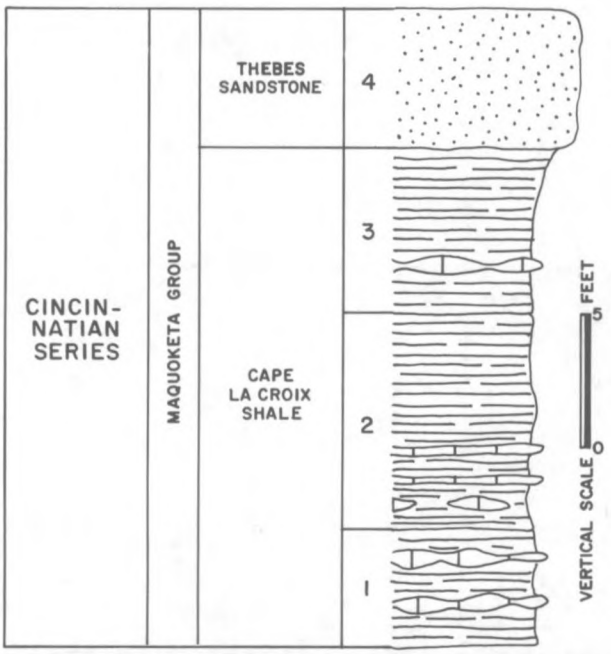
Gealy located the type section (figs. 144 and 145) in a stream bank exposure in the east fork of Cape La Croix Creek, located in the N½ SW¼ SW¼ SW¼ sec. 13, T. 31 N., R. 13 E., Cape Girardeau County, Missouri. Approximately 4 ft of the Thebes Sandstone overlies the "Randol shale" at this section.

In an unpublished dissertation at the University of Illinois, Rodgers (1972), also proposed the name **"Randol shale member"** for the upper shale member of the Moccasin Springs Formation of the Bainbridge Group (Upper Silurian) in southwestern Illinois. Because the latter concept (Rodgers') has been used extensively by geologists in the oil industry and among midwestern Silurian stratigraphers (J.W. Baxter, Ilinois Geological Survey, personal communication, 1984), it is not appropriate to use "Randol" for the lowest formation of the Maquoketa Group. This shale has been called "Maquoketa shale," but it is not entirely equivalent to the Maquoketa Shale of east-central and northeastern Missouri, but only to a lower portion of the Maquoketa; Berry and Marshall (1971) believe it is older than the Maquoketa Shale of east-central and northeastern Missouri (see "Remarks" under **Maquoketa Group - Maquoketa Shale**). A different name must therefore be used to distinguish the lowest shale of the Maquoketa Group in southeastern Missouri from the Maquoketa Shale of northeastern and east-central Missouri, and from the Orchard Creek Shale of southeastern Missouri. The formation is, therefore, herein named the **Cape La Croix Shale** of the Maquoketa Group.

The Cape La Croix Shale is a bluish-gray, calcareous, platy shale, with occasional limestone beds and nodules. It is 10 to 55 ft thick; in the type section it is about 17 ft thick (fig. 145). This shale lies disconformably on the Cape Limestone, and is overlain, possibly slightly disconformably, by the Thebes Sandstone.

Templeton and Willman (1963) did not recognize an equivalent to the Cape La Croix Shale in southwestern Illinois; they described the Thebes Sandstone as lying on the Cape Limestone. They stated (p. 131),

> "In southwestern Illinois and southeastern Missouri, on the flanks of the Ozark Dome, part or all of this unit [Gray, brown, and black shale containing subordinate proportions of interbedded limestone and having a



ORDOVICIAN SYSTEM - CINCINNATIAN SERIES
MAQUOKETA GROUP
Thebes Sandstone

4. Sandstone, gray-brown, very fine grained, silty. (2-4 ft)

Cape La Croix Shale

3. Shale, light-bluish-gray, calcareous, platy; weathers light-brown; nodular limestone layer 2 ft above base, and two very thin, siliceous, pyritic beds oxidized to red and yellow at base. (6 ft)
2. Shale, light-olive-gray, calcareous, platy at base, non-calcareous and more finely platy at top; weathers yellowish-brown; very thin limestone beds and abundant limestone nodules in lower 30 in., abundant fossil fragments. (7.5 ft)
1. Shale, medium-light-gray, calcareous, platy; weathers light-bluish-gray; 4- to 6-in. nodular, light-bluish-gray limestone beds, weather brownish-gray. (4.5 ft)

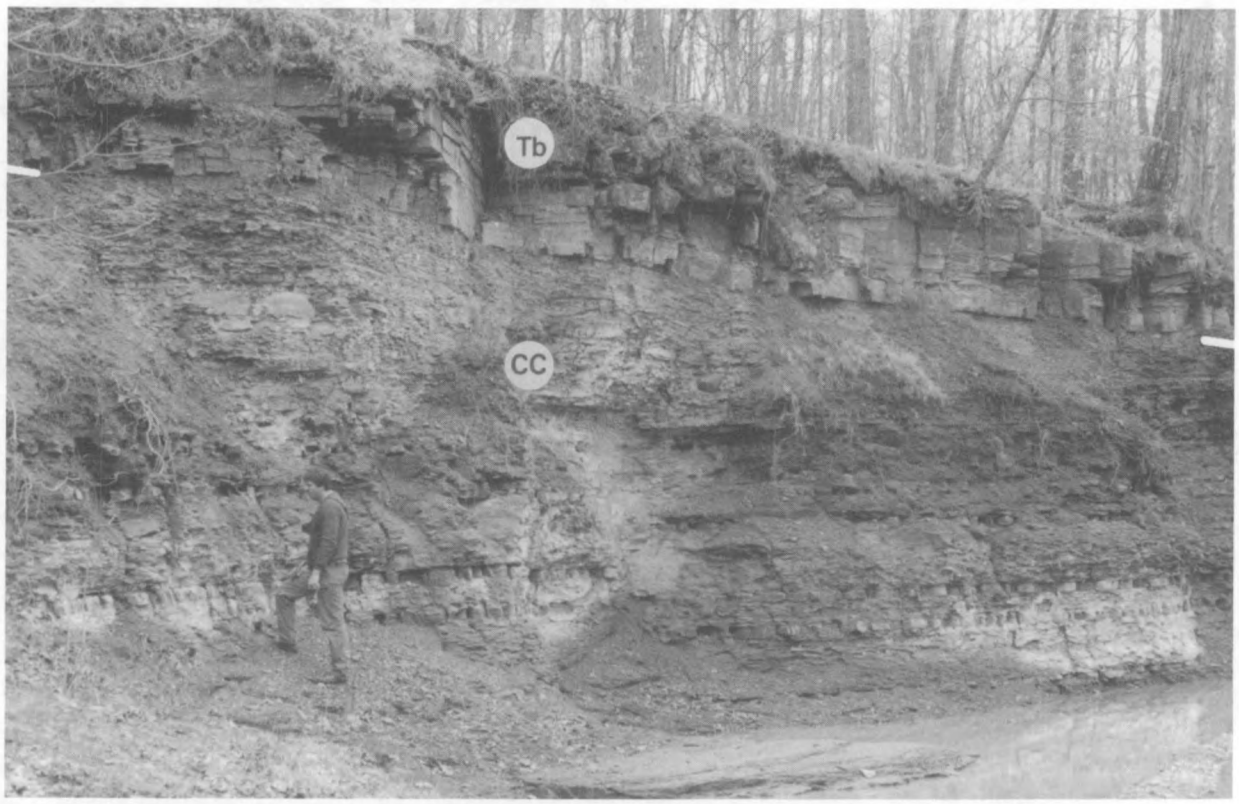


Figure 145. *Type section of the* **Cape La Croix Shale** *of the Maquoketa Group, SW¼ SW¼ SW¼ sec. 13, T. 31 N., R. 13 E., Cape Girardeau County (fig. 144). Adapted from a description by Gealy (1955).* (**CC**) *Cape La Croix Shale;* (**Tb**) *Thebes Sandstone. Photograph by T.L. Thompson.*

depauperate faunal zone at the base, equivalent to the Elgin Shale Member of the Maquoketa in Iowa] grades laterally into the dark brown sandstone, siltstone, and shale called the Thebes Sandstone (Worthen, 1866; Savage, 1909)."

Thebes Sandstone

Worthen, 1866

Original description -- (Worthen, 1866, p. 139) "This sandstone is well exposed in the bluffs at the town of Thebes, and has received locally the name of *Thebes sandstone*. It is a regularly bedded brown sandstone, sometimes massive, and affording excellent dimension stone for heavy masonry, as well as some thin beds suitable for flags."

Type section -- The type section for the Thebes Sandstone is the outcrop below the courthouse in the town of Thebes, Alexander County, Illinois, SE¼ SW¼ SE¼ sec. 8, T. 15 S., R. 3 W., Thebes 7½' Quadrangle.

Reference sections -- Sandstone of the Thebes has been described by Gealy (1955, unpublished manuscript) in an exposure on the east fork of Cape La Croix Creek, N½ SW¼ SW¼ SW¼ sec. 13, T. 31 N., R. 13 E., Cape Girardeau County, Missouri, Cape Girardeau 7½' Quadrangle (fig. 145).

The Thebes is also exposed in the upper part of the type section of the Cape Limestone (fig. 137), north of the junction of Main and Broadway Streets in Cape Girardeau, Cape Girardeau County, Missouri (see **Cape Limestone**).

History of nomenclature

1863	Shumard	Cape Girardeau sandstone of Hudson River group
1866	**Worthen**	**Thebes sandstone and shale**
1873	Shumard	Cape Girardeau sandstone
1904	Ulrich	Thebes formation (middle part)
1908	Savage	"Thebes sandstone and shale" (restricted; upper part)
1909	Savage	Thebes sandstone (upper part)
1911	Ulrich	"Thebes facies of Maquoketa shale"
1913	Savage	Thebes sandstone
1921	Dake	Thebes sandstone (upper part; included lower shale unit)
1944	Branson	Thebes sandstone (rejected as facies of Maquoketa)
1959	Sweet et al.	Thebes sandstone member of Orchard Creek formation ("Maquoketa")
1960	Pulse and Sweet	Thebes sandstone member of Orchard Creek formation ("Maquoketa")
1961	Martin et al. (a)	Thebes formation
1963	Templeton and Willman	Thebes Sandstone Member of Scales Formation
1975	Thompson and Satterfield	Thebes Sandstone
1976	Sweet and Bergström	Thebes Sandstone of Orchard Creek Shale (or Maquoketa)
1982	Thompson	Thebes Sandstone
1991	**Thompson (present report)**	**Thebes Sandstone**

Remarks -- Martin et al. (1961a, p. 31) stated,

> "The Thebes formation is typically a fine-grained quartzose sandstone which contains variable amounts of silt and mica. The sandstone is gray to bluish-gray and weathers to a yellowish-brown. At fresh exposures, the formation appears massive, but it soon weathers into shaly layers. Two prominent sets of nearly vertical joints are present in the sandstone and weathering along these joints causes the rock to break into large rectangular slabs.
>
> "The Thebes has been traced from Alexander County, Illinois, into southeastern Missouri and is recognized in northern Scott, eastern Cape Girardeau, Perry, and Ste. Genevieve Counties. The thickness of the formation ranges from less than 5 feet to as much as 20 or 25 feet in Missouri. The sandstone thins in the Ste. Genevieve County area and apparently feathers out in that county."
>
> "...In the subsurface of southeastern Missouri, several sandstone bodies are present in a shale sequence which lies between the Cape and Girardeau formations, and it is questionable as to which of these sandstones is the Thebes."

Martin et al. (1961a) believed the Thebes may be a southern facies of the Maquoketa shales that are exposed in east-central and northeastern Missouri. Southward, the shale of the Maquoketa becomes separated into two shales (Cape La Croix and Orchard Creek) by an intervening sandstone (Thebes). It is also possible that the Thebes and Cape La Croix may both be older than the Maquoketa Shale of northeastern Missouri (see "Remarks" under **Cape La Croix Shale** and **Maquoketa Shale - Maquoketa Group**).

Exposures of the Thebes Sandstone immediately north of the town of Thebes, in Alexander County, Illinois, along the banks of the Mississippi River (sec. 5, T. 15 S., R. 3 W.), indicate the Thebes may be at least in part composed of channel or deltaic deposits into the underlying strata; the fine nature of the sand may indicate deposition offshore in a deltaic environment.

Orchard Creek Shale

Savage, 1909

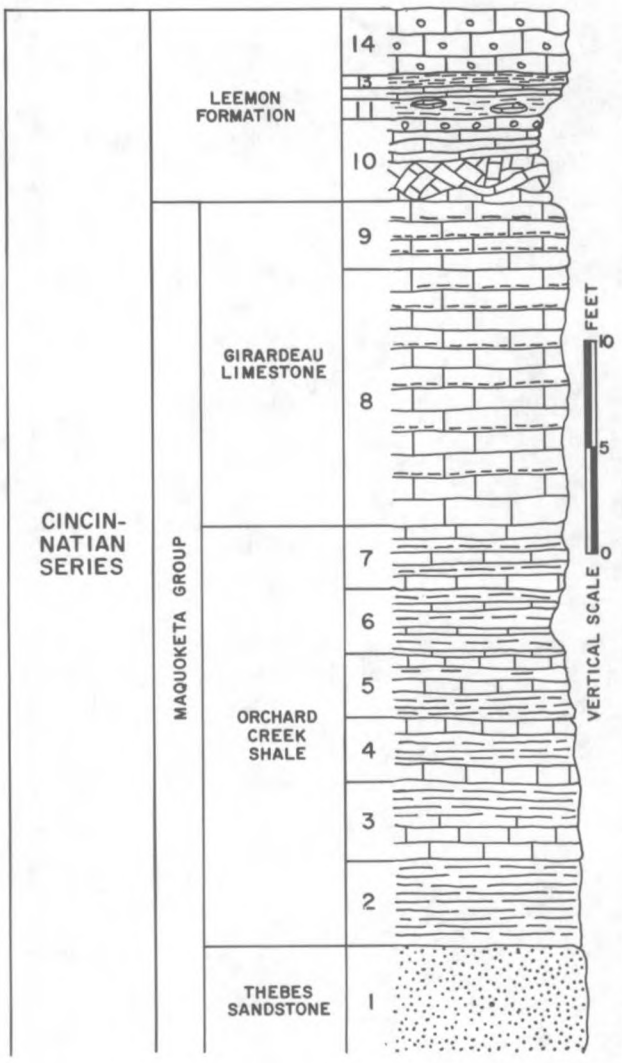
Original description -- (Savage, 1909, p. 515) "The name Orchard Creek shale is here proposed for a bed ... of calcareous shale exposed in the bank of Orchard Creek, about two miles south of Thebes. The formation is embraced between the Thebes sandstone below and the Girardeau limestone above. The material consists of banks of bluish-gray shale, four to six inches thick, alternating with two- to four-inch layers of impure, concretionary limestone. The maximum thickness of the bed is about twenty-two feet."

Type section -- The type section for the Orchard Creek Shale (now covered) is along Orchard Creek, 2 mi south of Thebes, Alexander County, Illinois, sec. 21, T. 15 S., R. 3 W.

Reference section -- The best reference section for the Orchard Creek Shale is across the Mississippi River from southern Cape Girardeau County, on the east bank of the Mississippi River 1 mi north of Thebes, Alexander County, Illinois, SE¼ SE¼ sec. 5, T. 15 S., R. 3 W., Thebes 7½' Quadrangle (fig. 146).

History of nomenclature

1908	Savage	"upper member in a bed of fossiliferous, bluish shale"
1909	**Savage**	**Orchard Creek shale**
1926	Savage	Orchard Creek shale (Silurian in age)
1941	Ball	Orchard Creek (Alexandrian)
1942	Willman and Payne	"lower brown shale member" of Maquoketa formation (upper part)
	Ball	Orchard Creek
1945	DuBois	"lower shale zone" of Maquoketa formation (upper part)
1955	Grohskopf	Thebes-Maquoketa formation (upper part)
1958	Herold et al.	"Orchard Creek formation (Silurian)"
	Gudstadt	Orchard Creek shale (may include Maquoketa Shale of east-central Missouri)
1959	Sweet et al.	"shale member of Orchard Creek ('Maquoketa') Formation"
1961	Martin et al. (a)	Orchard Creek (?) formation
1963	Templeton and Willman	Orchard Creek Shale Member of Scales Formation
1971	Satterfield	Orchard Creek Shale
	Amsden	Maquoketa Shale
1975	Thompson and Satterfield	Orchard Creek Shale
1979	Kolata and Guensburg	Orchard Creek Shale of Maquoketa Group (southwestern Illinois)
1982	Thompson	Orchard Creek Shale
1986	Amsden	Orchard Creek Shale
1991	**Thompson (present report)**	**Orchard Creek Shale**



ORDOVICIAN SYSTEM - CINCINNATIAN SERIES

Leemon Formation (9 ft)

14. Limestone, brown and gray, coarse-grained, oolitic; thick beds with incipient irregular nodular shale partings. (3 ft)
13. Shale, gray-green, blocky to platy. (6 in.)
12. Limestone, gray, finely crystalline; no oolites. (6 in.)
11. Shale, gray-green, blocky to platy; very irregular top; 2-4 in. limestone lenses in upper part; trilobites (*Dalmenella*) and brachiopods abundant in limestone. (1 ft)
10. Limestone, dark-gray, coarse-grained, oolitic, conglomeratic; rounded boulders of lithographic Girardeau Limestone within oolitic Leemon matrix; cross-bedded; thickest to south, thins to several 6 in. - 1 ft beds northward; scattered Girardeau found throughout, brown chert of Girardeau, not present in Girardeau at section, is present in conglomerate. (4 ft)

10D. Limestone, dark-gray, fine- to medium-grained, oolitic. (6 in.)

10C. Limestone, sublithographic, very dense; in even 2-6 in. beds. (1 ft 6 in.)

10B. Limestone conglomerate (1 ft)

10A. Limestone, no conglomerate (1 ft)

MAQUOKETA GROUP

Girardeau Limestone (15 ft)

9. Limestone, gray to very light-gray, sublithographic at base to lithographic top half; beds become very discontinuous and nodular in upper half; top irregular, disconformable. (3 ft)
8. Limestone, gray, fine-grained; as very nodular, continuous beds separated by gray-green clay shale partings; shale 5-10%; increasing downward. (12 ft)

Orchard Creek Shale (20 ft)

7. Limestone and shale, alternating 1-3 in. limestone beds and 1-2 in. gray-green shale; 75-90% limestone. (3 ft)
6. Limestone and shale, 50-50; alternating beds. (3 ft)
5. Shale and limestone, 70% shale. (3 ft)
4. Shale and limestone, three 1-in. limestone beds within gray-green, clay shale. (3 ft)
3. Shale, gray-green, calcareous, silty, platy; discontinuous nodular lithographic limestone beds. (3 ft 9 in.)
2. Shale, green-gray, silty, weakly platy. (4 ft)

Thebes Sandstone (35 ft+)

1. Sandstone, brown, laminated; thin, slabby beds; base beneath river level; top surface polished and potholed. (35 ft +)

Figure 146. **Thebes Sandstone** *and* **Orchard Creek Shale** *of the Maquoketa Group and* **Leemon Formation** *exposed along the east bank of the Mississippi River north of Thebes, SE¼ SE¼ sec. 5, T. 15 S., R. 3 W., Alexander County, Illinois. Adapted from a description by Thompson and Satterfield (1975).*

Remarks-- Martin et al. (1961a, p. 31-32) stated,

> "The shale unit which lies above the Thebes formation and below the Girardeau formation in Missouri... the Orchard Creek formation...is composed of olive green to bluish-gray shale and intercalated beds of limestone. The shale is platy, calcareous, and generally weathers brown. The limestone beds are argillaceous and thin in the lower part of the unit but become less so upward where they resemble the limestone of the overlying Girardeau formation. Fossils are present in both the limestone and shale but are not abundant. The contact of the Orchard Creek with the underlying Thebes formation is generally gradational, but locally it is sharp and distinct. The average thickness of the formation is 50 feet. The formation's contact with the overlying Girardeau appears transitional. The unit is present in Cape Girardeau, Perry and Ste. Genevieve Counties."

The Orchard Creek Shale is composed primarily of bluish-gray calcareous shale in the lower part. Intercalated limestone beds increase in number in the upper third of the formation. Because the limestone is like that of the overlying Girardeau Limestone, the contact between the Orchard Creek and Girardeau is transitional (fig. 147).

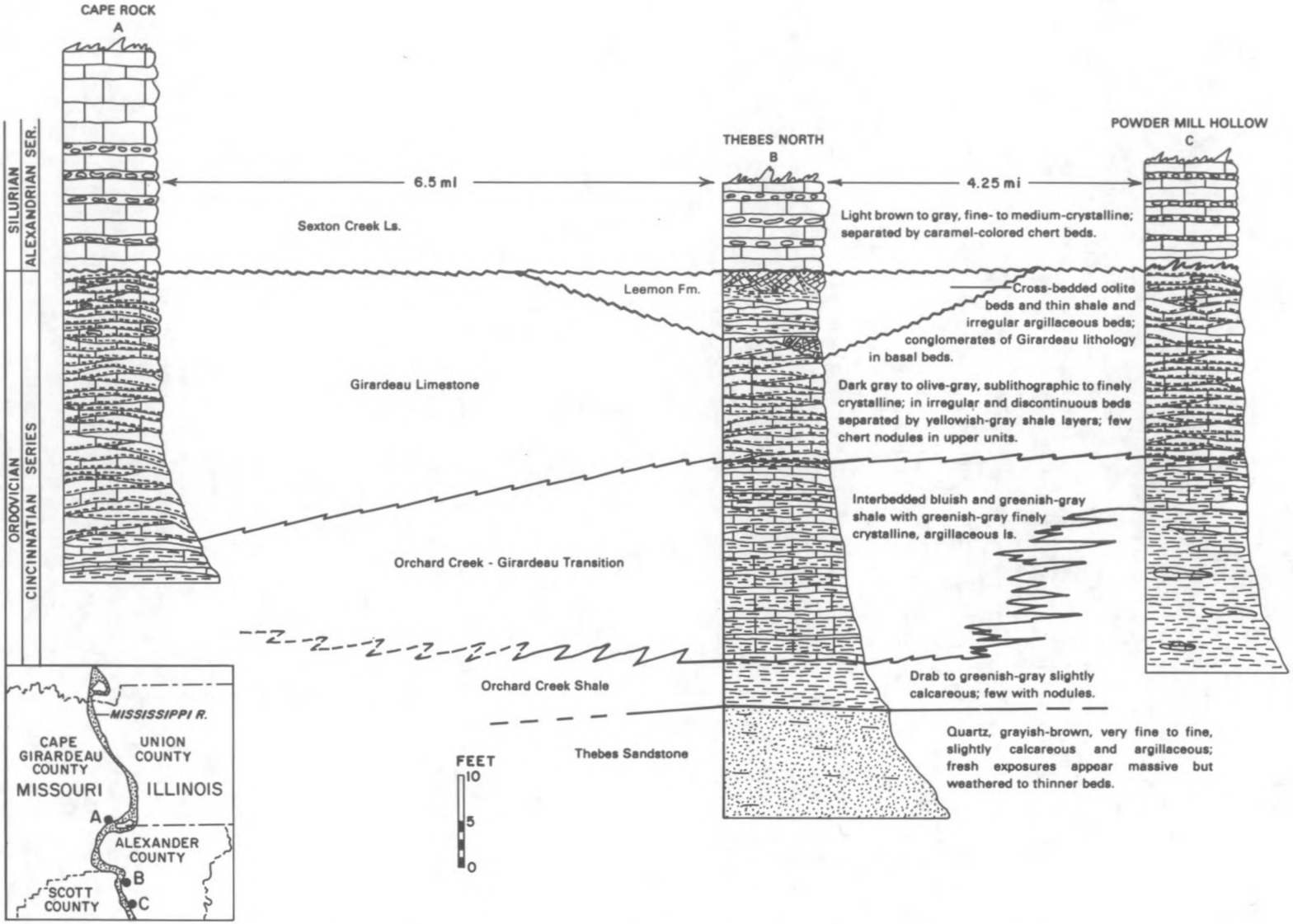


Figure 147. *Stratigraphic relation of* **Thebes Sandstone, Orchard Creek Shale,** *and* **Girardeau Limestone** *with the overlying* **Leemon Formation** *in Cape Girardeau County, Missouri and Alexander County, Illinois. Adapted from Satterfield (1971).*

Based on conodonts, Satterfield (1971) assigned the Girardeau to the Late Ordovician Cincinnatian Series, and Sweet et al. (1975) to the Richmondian Stage of the Cincinnatian Series. Pryor and Ross (1962), using graptolites, and Brower (1973), crinoids, had earlier proposed the same age determation as Sweet et al. Kolata and Guensburg (1979, p. 1122) stated,

> "Based on conspecific crinoids that we have collected, the age of the underlying Orchard Creek is probably also Richmondian. *Diamphidiocystis* was probably a contemporary of the well known mitrate genus *Enoploura* of the Cincinnatian Series in Indiana, Ohio, and Kentucky (Caster, 1952)."

Girardeau Limestone

Shumard, 1855

Original description -- (Shumard, 1855, p. 152) "From one and a half to two miles above Cape Girardeau, is an exposure of about forty feet of bluish gray limestone, in layers from two to six inches thick, and traversed by numerous vertical joints. The rock is very compact, and breaks with a smooth, splintery fracture. The weathered surfaces are frequently covered with a thin film of oxide of iron. In some portions of the mass, fossils occur in great variety and abundance."

Type section -- Satterfield (1971, p. 266) stated the type section of the Girardeau Limestone (figs. 148-150) "... at Cape Rock, is located in the W½ NE¼ SE¼ sec. 28, T. 31 N., R. 14 E., Cape Girardeau County,

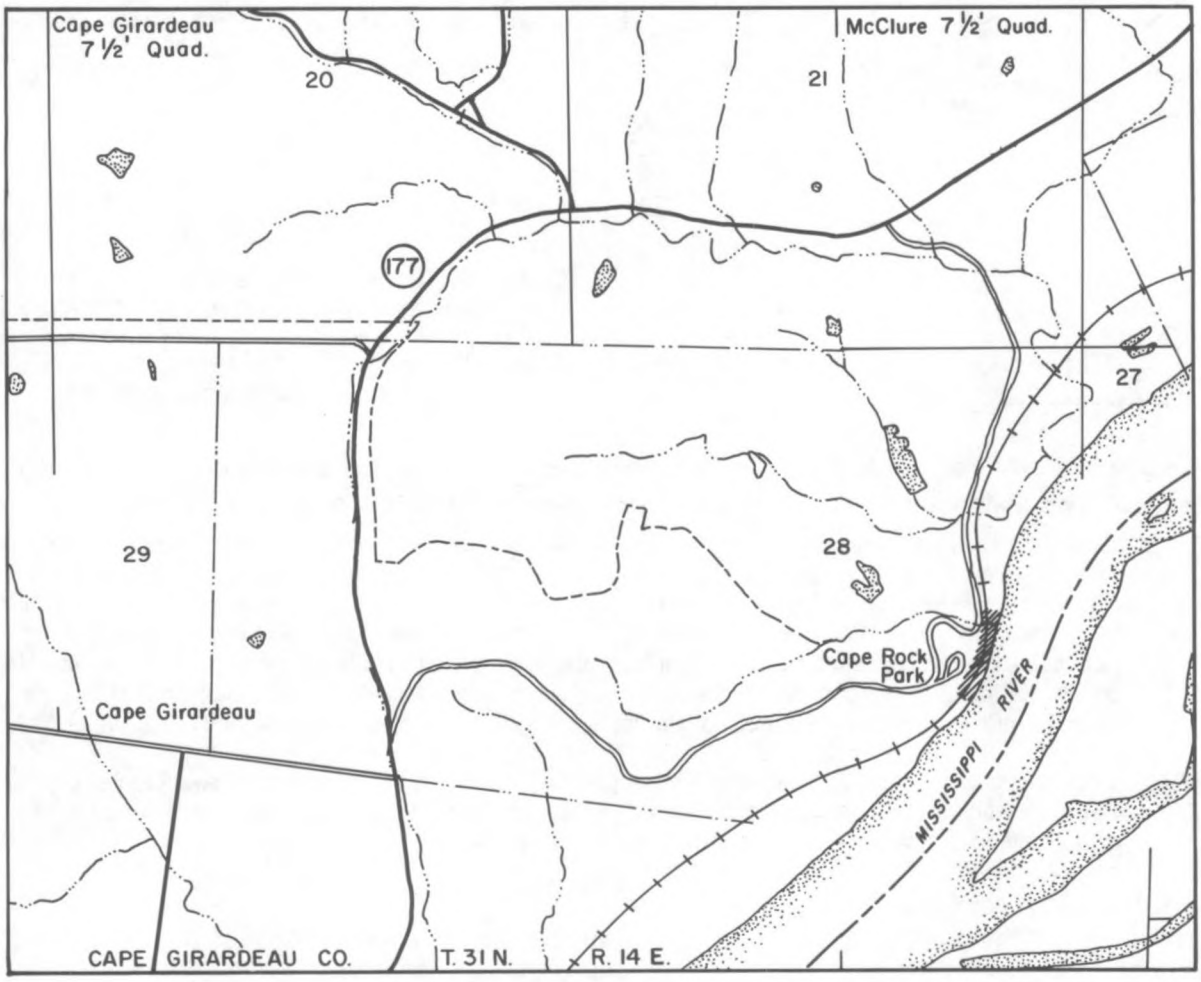
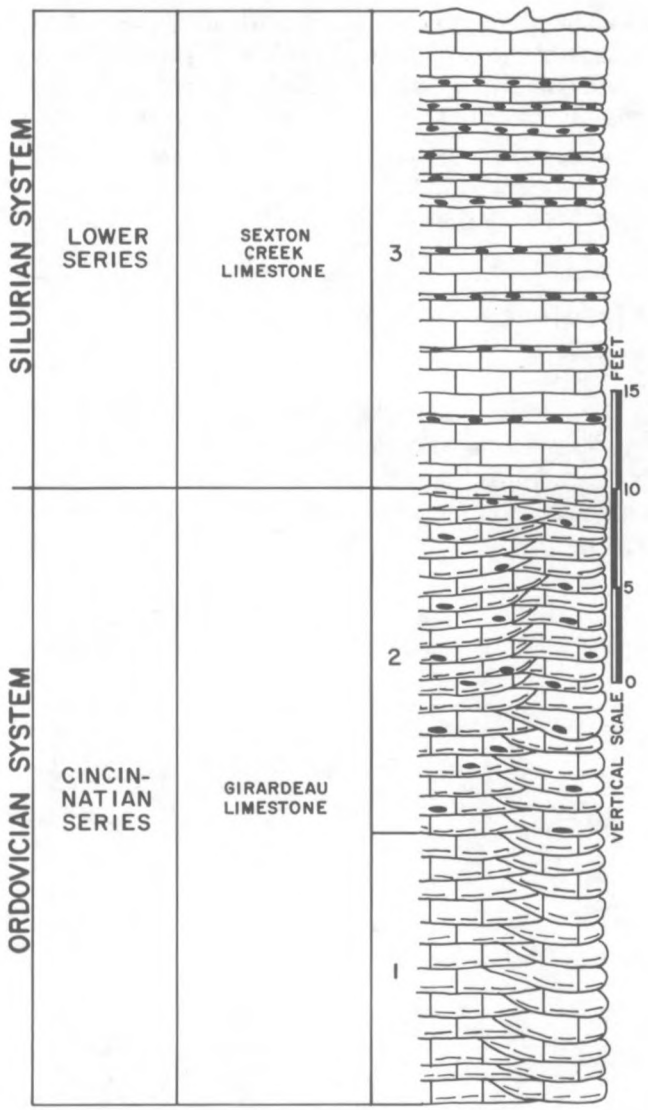


Figure 148. *Parts of the Cape Girardeau and McClure Illinois- Missouri 7½' quadrangles, showing location of the type section of the* **Girardeau Limestone,** *W½ NE¼ SE¼ sec. 28, T. 31 N., R. 14 E., Cape Girardeau County, Missouri.*



SILURIAN SYSTEM

Sexton Creek Limestone (25 ft)

3. Limestone, greenish-gray to gray, very finely to finely crystalline; 6-20 in. beds separated by continuous, yellowish-gray, 1-4 in. chert beds; lower beds very fossiliferous, upper beds less so; upper beds more glauconitic, with less chert; chert yellowish-blue, very resistant and nodular; chert beds are farther apart in lower 7-8 ft, close in middle, farther apart in upper part; "cabbage-head" structures in upper beds. (25 ft)

ORDOVICIAN SYSTEM - CINCINNATIAN SERIES

Girardeau Limestone (33 ft)

2. Limestone, gray to dark-gray, sublithographic to lithographic, progressively denser upward, breaks with conchoidal fracture, mudcracks; discontinuous, undulatory, lenticular 2-6 in. beds separated by 0.25-0.5 in. yellowish-gray, laminated, calcareous shale layers; chert, drab to bluish, nodular, abundant in upper part. (18 ft)
1. Limestone, gray to olive-gray, finely crystalline, argillaceous, beds undulatory, 1-4 in. thick, separated by 0.1-1-in. shale partings, become progressively thinner and more shaly downward; lateral extent greater than in unit no. 2; chert-free; unfossiliferous. (15 ft)

Figure 149. *Type section of the* **Girardeau Limestone,** *and overlying railroad exposure, showing relationship of Girardeau to the overlying Lower Silurian Sexton Creek Limestone (fig. 148). Adapted from a description by Thompson and Satterfield (1975).*

Missouri, along the west bank of the Mississippi River and along the St. Louis and San Francisco Railroad (McClure, Illinois-Missouri 7½-minute Quadrangle)." He described the type section as follows:

3. Limestone, greenish-gray to gray, very finely to finely crystalline; 6-20 in. beds separated by continuous, yellowish-gray, 1-4 in. chert beds; lower beds very fossiliferous, upper beds less so; upper beds more glauconitic, with less chert; chert yellowish-blue, very resistant and nodular; chert beds are farther apart in lower 7-8 ft, close in middle, farther apart in upper part; "cabbage-head" structures in upper beds. (25 ft)
2. Limestone, gray to dark-gray, sublithographic to lithographic, progressively denser upward; breaks with conchoidal fracture; mudcracks; discontinuous, undulatory, lenticular 2-6 in. beds separated by 0.25-0.5 in. yellowish-gray, laminated, calcareous shale layers; abundant drab to bluish, nodular chert in upper part. (18 ft)
1. Limestone, gray to olive-gray, finely crystalline, argillaceous; beds undulatory, 1-4 in. thick, separated by 0.1-1 in. shale partings, beds become progressively thinner and more shaly downwards; lateral extent greater than in unit no. 2; chert-free; unfossiliferous. (15 ft)

History of nomenclature

1855	**Shumard**	**Cape Girardeau Limestone**
1897	Schuchert	Cape Girardeau limestone
1898	Keyes	Girardeau
1902	Weeks	Girardeau limestone

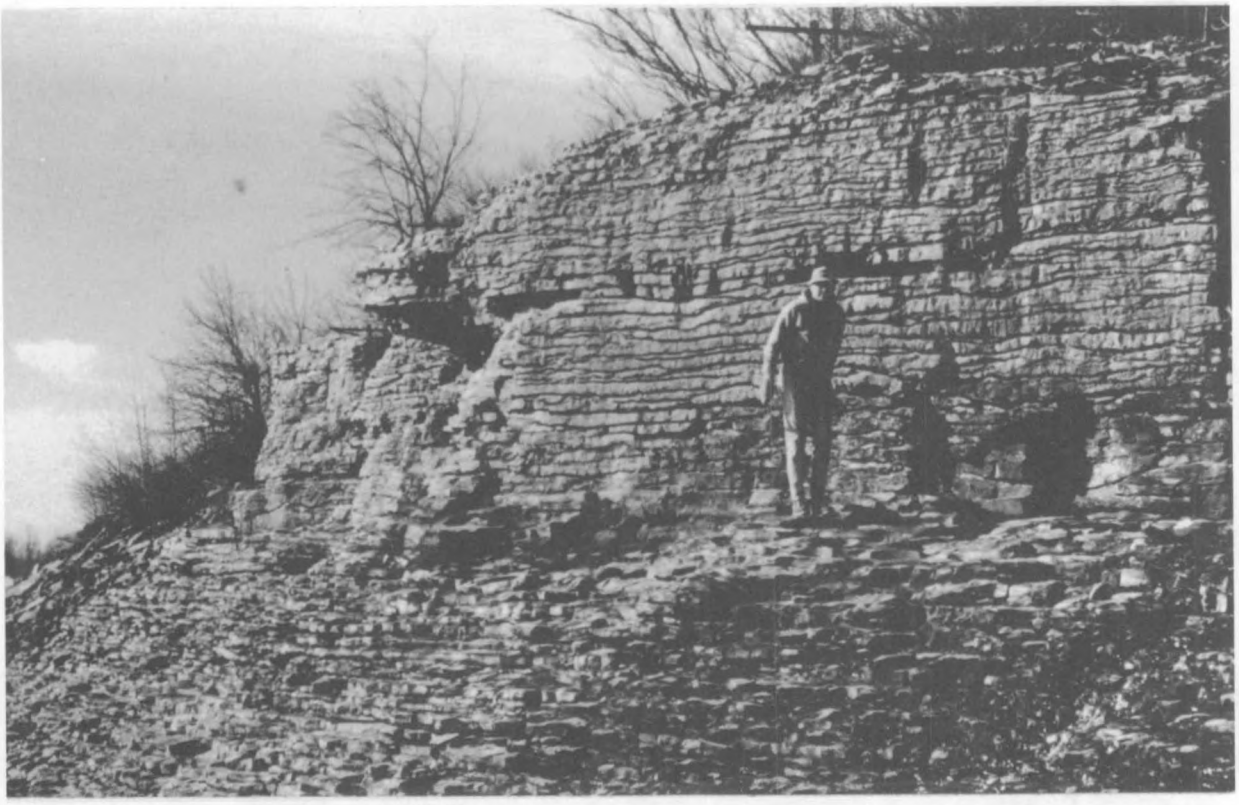


Figure 150 (A) ▲ Figure 150 (B) ▼

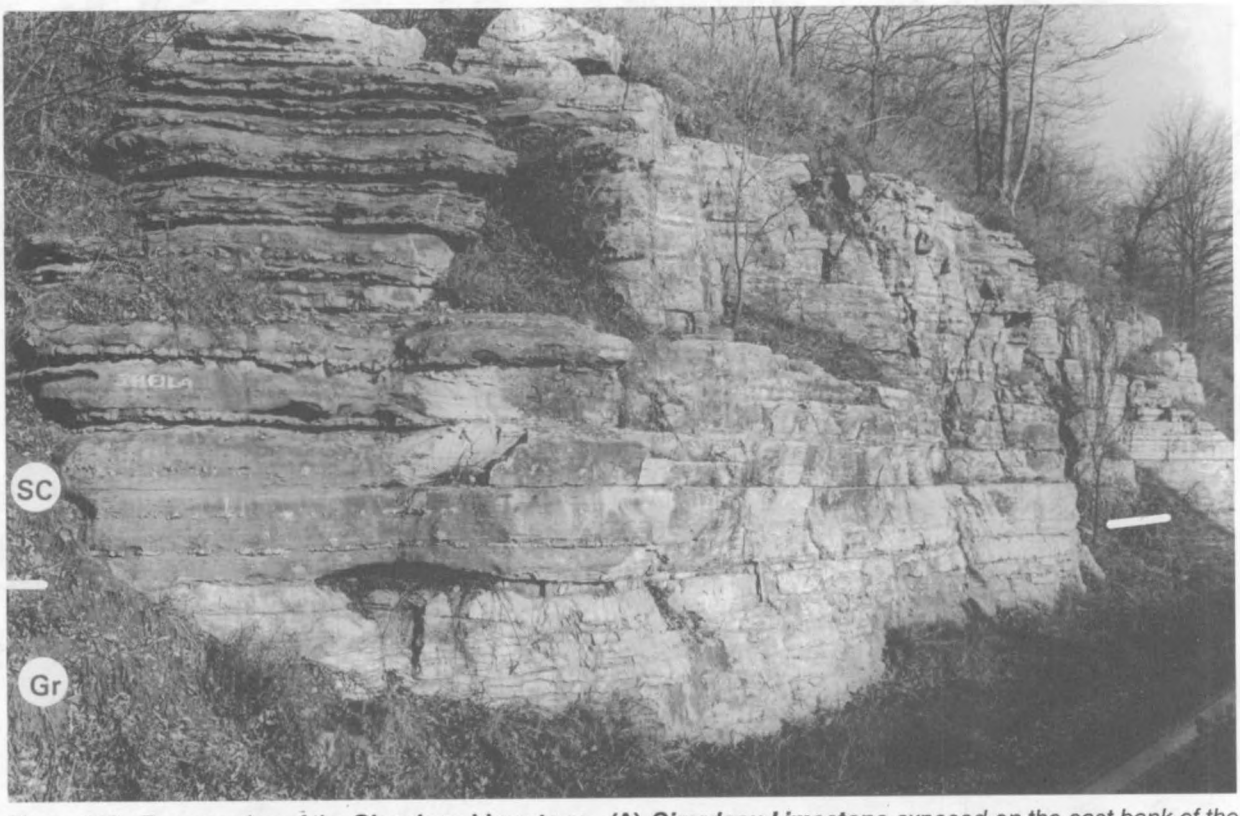


Figure 150. *Type section of the* **Girardeau Limestone.** **(A)** ***Girardeau Limestone*** *exposed on the east bank of the Mississippi River below the railroad track (fig. 148).* **(B)** *Railroad exposure above A, near the type section of the* ***Girardeau Limestone*** *(fig. 149), showing the relationship of the Girardeau Limestone* **(Gr)** *to the overlying Lower Silurian Sexton Creek Limestone* **(SC).** *Photographs by T.L. Thompson and I.R. Satterfield.*

1908	Savage	Cape Girardeau limestone (lower part)
1909	Savage	Girardeau limestone (removed "Cape"; considered Silurian in age)
	Grabau	"Cape Girardeau or Alexandrian formation"
1925	Jones	"Upper Medinan (Girardeau) of Missouri"
1936	Ireland	Girardeau limestone (lower Silurian)
1938	Scobey	Cape Girardeau (Girardeau) limestone (Alexandrian series)
1954	Twenhofel et al.	Girardeau limestone (Ordovician)
1955	Grohskopf	Girardeau formation (Silurian)
1961	Martin et al. (a)	Girardeau limestone
1963	Templeton and Willman	Girardeau Limestone (Silurian in age)
1971	Satterfield	Girardeau Limestone (**established definite Late Ordovician age for Girardeau**)
1979	Kolata and Guensburg	Girardeau Limestone of Maquoketa Group (southwestern Illinois)
1982	Thompson	Girardeau Limestone
1986	Amsden	Girardeau Limestone
1991	**Thompson (present report)**	**Girardeau Limestone**

Remarks -- Martin et al. (1961a, p. 34) stated,

> "The Girardeau is a dark to medium gray limestone which weathers to a light bluish gray. The texture of the limestone is dense to sublithographic, and the rock breaks with a conchoidal fracture. Bedding is thin and irregular with individual beds pinching out in short distances. Black and dark brown chert nodules are irregularly scattered throughout the upper part of the formation. Intercalated with the limestone beds, especially in the lower part, are yellowish-brown and olive, calcareous shale partings. Fossils are generally sparse in the limestone beds but are fairly abundant in many of the shale partings. The thickness of the formation ranges from a few feet to a maximum of 40 feet. The upper boundary of the Girardeau is marked by an erosional unconformity. The Girardeau formation in Missouri is restricted mainly to Cape Girardeau County."

Satterfield (1971, p. 266) stated,

> "The Girardeau is essentially dark-gray to olive-gray sublithographic to finely crystalline limestone in irregular and discontinuous beds (2 to 6 inches thick) with interbedded (1/8 to 1 inch) yellowish-gray laminated shale layers. This formation has a unique weathered appearance caused by the more rapid weathering of the laminated shale layers than of the associated limestone beds [fig. 150A]. A total thickness of 33 feet of Girardeau can be measured at its type locality during low water level.
>
> "The upper 15 to 18 feet consist of gray to dark-gray, sublithographic to very finely crystalline, slightly fossiliferous limestone beds that break with conchoidal fracture and contain solution cracks. The laminated shale layers associated with this unit are calcareous and dolomitic and contain drab and bluish-black chert nodules..."
>
> "The lower limestone beds are gray to olive-gray, very fine to finely crystalline, fossiliferous, argillaceous, and free of chert. The laminated shale layers common to this unit are much less calcareous and dolomitic and slightly thicker than in the upper beds of the Girardeau."

The contact with the underlying Orchard Creek Shale is transitional (fig. 147), the limestone increasing in the Orchard Creek until the unit is essentially all limestone; *i.e.*, the Girardeau. The upper contact, distinctly disconformable (figs. 147, 149, and 150B), is with the Lower Silurian Sexton Creek Limestone at the type section and some other sections, and with the Late Richmondian (Cincinnatian) Leemon Formation elsewhere. Clasts of Girardeau lithology are found in basal Leemon strata. The Leemon itself was removed from some areas by pre-Sexton Creek erosion.

The age of the Girardeau Limestone was firmly established by Satterfield (1971, p. 265-266), who stated,

> "The exact age of the Girardeau Limestone has been in doubt for more than one hundred years. The most complete megafaunal studies were conducted by Savage (1908, 1910, 1913a, 1913b, 1917). Savage consistently concluded the Girardeau to be of early Silurian age. Weller & Ekblaw (1940, p. 9) concluded that the Girardeau should be placed in the very late Ordovician rather than in the very early Silurian, but they

included it in the discussion of the Silurian System (p. 8) and listed it as Silurian in their stratigraphic section (p. 7). In 1963, Templeton & Willman (p. 133) assigned the Orchard Creek to the Maquoketa Group (Ordovician) and retained the Girardeau in the Silurian on faunal grounds. However, Willman et al. (1967) placed the Girardeau within the Cincinnatian (Upper Ordovician) on the geologic map of Illinois."

Satterfield (1971) identified several conodonts from the Girardeau Limestone, including *Prioniodus girardeauensis, P. ferrarius*, and *Exochognathus brevialata*, that were also common in the underlying Orchard Creek Shale, and concluded that (p. 270)

"A very late Ordovician age is here assigned to the Girardeau Limestone in its known outcrop belt. This conclusion is based on the closer relationship of the conodonts to the forms from the Cincinnatian than to those of the Silurian. Physical evidence...help substantiate this fact."

Leemon Formation

Thompson and Satterfield, 1975

Original description -- (Thompson and Satterfield, 1975, p. 77) "The Leemon Formation is dominantly oolitic, fossiliferous, cross-stratified, gray to brown calcarenite that contains clasts of Girardeau limestone and phosphatic pebbles. Locally, the Leemon also includes medium to coarsely crystalline bioclastic and argillaceous limestone and shale. The Leemon ranges from 0 to approximately 7 m in thickness."

Type section -- Thompson and Satterfield (1975, p. 77) stated "The section designated as the type for the Leemon Formation is about 100 m below the head of the drainage 100 m east of the barn in the SE¼ NE¼ SW¼ sec. 21, T. 32 N., R. 13 E., Cape Girardeau County, Missouri (Cape Girardeau NE 7½' quad.)." At this section, (figs. 151-153), also known as the "Short's farm section," the Leemon lies on Maquoketa (Orchard Creek Shale), and is overlain by Sexton Creek Limestone.

Reference section -- Another excellent exposure of the Leemon Formation is near the small town of New Wells (fig. 154), exposed in the east bank and channel of Blue Shawnee Creek, 0.5 mi east of New Wells, NW¼ SE¼ SE¼ sec. 9, T. 33 N., R. 13 E., Cape Girardeau County, Missouri, Neelys Landing 7½' Quadrangle. At this section, small bioherms are present in the lower part of the Leemon, and the whole

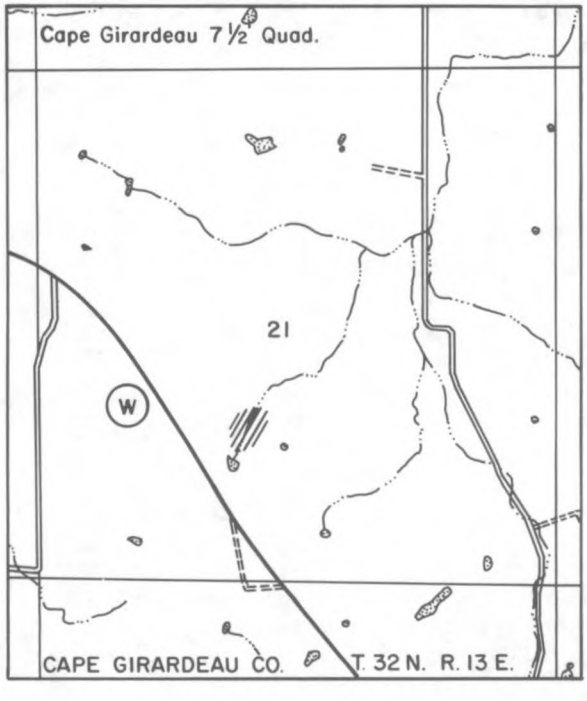
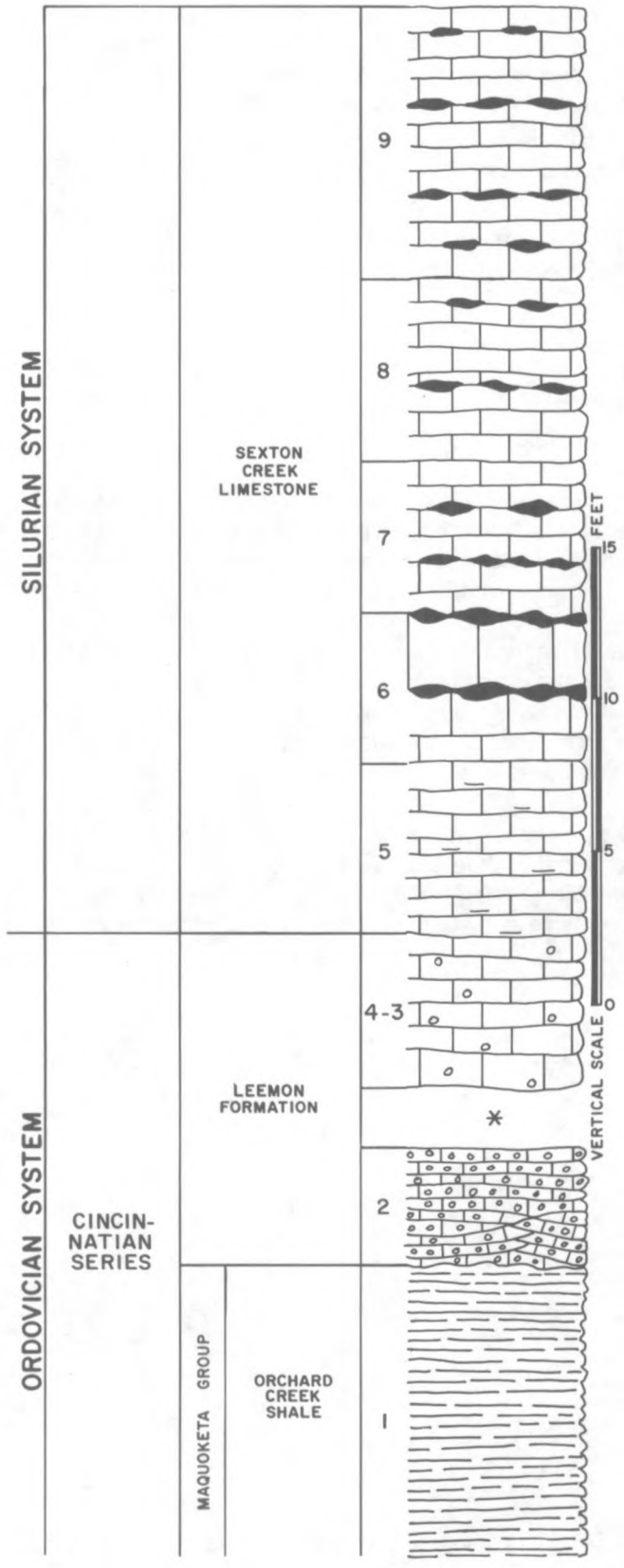


Figure 151. *Part of the Cape Girardeau NE 7½' Quadrangle, showing the location of the type section of the* **Leemon Formation,** *SE¼ NE¼ SW¼ sec. 21, T. 32 N., R. 13 E., Cape Girardeau County, Missouri.*



SILURIAN SYSTEM

Sexton Creek Limestone (35 ft+)

9. Limestone, light-gray to gray, finely to medium-crystalline, massive; slightly glauconitic, stylolitic, traces of pyrite; crinoid fragments; chert in 1-3 in. beds, varying from white with white crinoid fragments, to bluish-gray and translucent, whitish-gray and semitranslucent, a few beds are caramel with crinoid fragments; some "cabbage-head" chert. (8 ft 11 in.)
8. Limestone, light-brown to caramel, and light-gray to gray, medium-crystalline, slightly argillaceous; crinoid fragments; carmel chert (10%), as scattered beds of 0.5-2 in. nodules. (6 ft)
7. Limestone, as no. 8; finely to medium-crystalline; more crinoid fragments visible; chert (10%). (5 ft)
6. Limestone, as above; dendrites; massive (9 in. - 2 ft) beds, separated by two caramel chert beds. (5 ft)
5. Limestone, light-brown to caramel, finely to medium-crystalline, slightly argillaceous, very finely crystalline matrix; a few beds are gray to pale yellowish-gray; medium to coarsely crystalline, slightly pelletal, with crinoid debris; dendrites; thin, irregular, 0.15-0.75 in. beds; traces of crinoid fragments. (5 ft 6 in.)

ORDOVICIAN SYSTEM - CINCINNATIAN SERIES

Leemon Formation (11 ft)

4-3. Limestone, light-yellowish-gray, medium- to coarsely crystalline; slightly pelletal; sparsely oolitic; oolites of medium-sand size; stylolitic; lower 2 ft massive (8 in.-1 ft), beds slightly crossbedded; upper 2-ft thinner bedded and irregular; contains a few traces of green shale pebbles; abundant crinoid debris, some silicified fossils (corals). (5 ft)

Covered interval (2 ft)

2. Limestone, light-gray to grayish-black, medium sand- to very coarse sand-sized calcarenite; oolitic, some oolites appear to be phosphatic; very glauconitic; lower 18 in. extremely cross-bedded, beds 2-4 in. thick, conglomeratic, with pebbles of Girardeau Limestone, beds separated by 0.15-0.25 in. calcareous shale partings, a few traces of green shale pebbles; upper 30 in. thicker bedded, not as cross-bedded, slightly oolitic; upper 6 in. phosphatic, stylolitic. (4 ft)

MAQUOKETA GROUP

Orchard Creek Shale (17 ft)

1. Shale; lower 2.5 ft dark-green-gray, beds 0.1-0.25 in.; upper 3 ft brownish-green, beds 0.25-1 in. thick; weathers blocky and jointed. (17 ft)

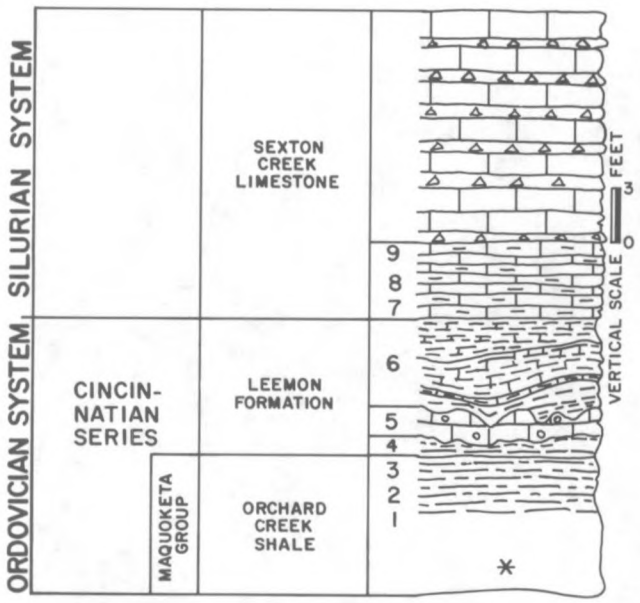
Figure 152. *Type section of the* **Leemon Formation,** *SE¼ NE¼ SW¼ sec. 21, T. 32 N., R. 13 E., Cape Girardeau County, Missouri (fig. 151). Adapted from a description by Thompson and Satterfield (1975).*

Figure 153. *Type section of the* **Leemon Formation,** *SE¼ NE¼ SW¼ sec. 21, T. 32 N., R. 13 E., Cape Girardeau County, Missouri (fig. 152).* **(Mq)** *Maquoketa Group;* **(Le)** *Leemon Formation;* **(SC)** *Sexton Creek Limestone. Photograph by T.L. Thompson.*

formation has a maximum thickness of about 6 ft. This section was described in detail by Thompson and Satterfield (1975, p. 80) and Amsden (1986, p. 32-34).

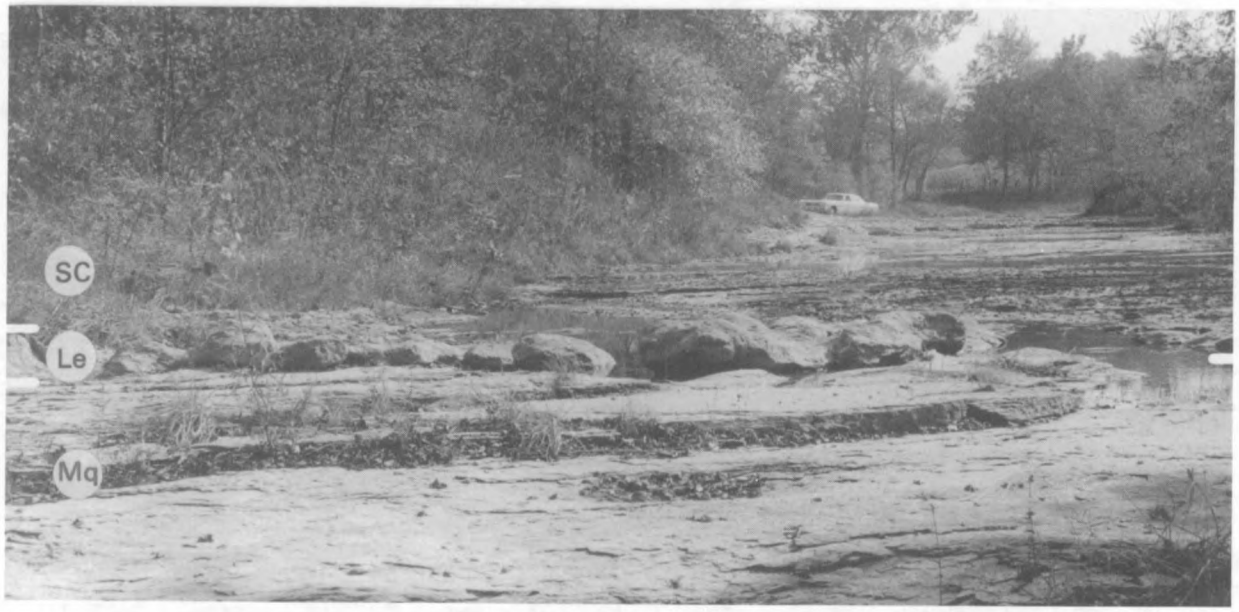
History of nomenclature

1909	**Savage**	**Edgewood limestone (part; southeastern Missouri only)**
1913	Savage	Edgewood limestone
1925	Jones	Edgewood ("Ordovician and Silurian affinities")
1926	Flint and Ball	Edgewood limestone (southeastern Missouri; "= Cyrene of northeastern Missouri")
1944	Branson	Edgewood formation (part; southeastern Missouri)
1961	Martin et al. (b)	Edgewood formation (southeastern Missouri)
1963	Amsden	Edgewood Limestone ("= Keel/Ideal Quarry of Oklahoma")
1971	Thompson and Satterfield	Edgewood Formation (part; southeastern Missouri only)
1974	**Amsden**	**Leemon Formation** (from ms. of Thompson and Satterfield)
1975	**Thompson and Satterfield**	**Leemon Formation** (formally proposed)
1979	Sable	Edgewood Limestone
1982	Thompson	Leemon Limestone
1986	Amsden	Leemon Formation of Edgewood Group
1991	**Thompson (present report)**	**Leemon Formation**



SILURIAN SYSTEM
Sexton Creek Limestone (7 ft+)
9-7. Limestone, bluish-gray, argillaceous, abundant crinoid fragments. (7 ft)
ORDOVICIAN SYSTEM - CINCINNATIAN SERIES
Leemon Formation (4-5 ft)
6. Limestone and shale; shale very fossiliferous lower 1 ft. (3 ft)
5. Limestone, bluish, medium-crystalline, nodular bioherms, oolitic; very fossiliferous, siliceous. (0-1 ft 6 in.)
4. Shale, gray, clayey. (6 in.)
MAQUOKETA GROUP
Orchard Creek Shale (7 ft+)
3-1. Shale, hard, silty, platy; in creek bottom. (7 ft+)

Figure 154. *Orchard Creek Shale* **(Mq), Leemon Formation (Le)** *and overlying Sexton Creek Limestone* **(SC)** *at New Wells, NW¼ SE¼ SE¼ sec. 9, T. 33 N., R. 13 E., Cape Girardeau County, Missouri. Adapted from a description by Thompson and Satterfield (1975). Photograph by T.L. Thompson.*



Remarks -- Thompson and Satterfield (1975, p. 77) stated,

> "The Leemon Formation is dominantly oolitic, fossiliferous, cross-stratified, gray to brown calcarenite that contains clasts of Girardeau limestone and phosphatic pebbles. Locally, the Leemon also includes medium to coarsely crystalline bioclastic and argillaceous limestone and shale. The Leemon ranges from 0 to approximately 7 m in thickness."

Until 1974, this unit was considered to be part of the **Edgewood Formation**; the type section of the Edgewood is in northeastern Missouri. Thompson and Satterfield (1975) redefined the Edgewood strata in northeastern Missouri to include both Late Ordovician and Early Silurian formations. They removed the southeastern "Edgewood" from the Group, renaming it the **Leemon Formation**; the type section in southeastern Missouri (Amsden, 1986, however, still includes the Leemon within the Edgewood Group). Geographically and lithologically distinct from Late Ordovician strata in northeastern Missouri, although with some similarities, the Leemon Formation was given a separate identity to better clarify understanding of Late Ordovician - Early Silurian relationships.

Amsden (1986) described the characteristics of the Leemon Formation at its type section. He stated (p. 31),

"Broken ooliths are also common in this part of the Leemon [lower 6 ft] as well as numerous rounded pebbles and cobbles of micritic limestone ranging up to 8 inches (20 cm) in length. Lithologically, these limestone pebbles have a striking resemblance to the Girardeau Limestone, but the Girardeau is not present here and the Leemon rests directly on the Orchard Creek Shale. However, similar pebbles are present at the base of the Leemon Formation near Thebes [Illinois] where this formation does rest on the Girardeau. In all probability the pebbles at the Short Farm locality were derived from the Girardeau, with all *in situ* traces of this formation stripped away by pre-Leemon erosion...These relationships indicate a pre-Leemon unconformity, although its duration is not ascertainable from present biostratigraphic information."

In a study of Hirnantian (youngest Ordovician) strata in the Midcontinent of North America, Amsden (1986, p. 34) listed the following brachiopod fauna from the Leemon Formation at the Blue Shawnee Creek (New Wells) locality:

Strophomena satterfieldi
Thaerodonta johnsonella
Leptaena aequalis
Biparetis paucirugosus
Dolerorthis savagei
Dalmanella testudinaria
Cliftonia tubulistriata
Leptoskelidion septulosum
Stegerhynchus concinna
Thebesia thebesensis
Whitfieldella billingsana

The Leemon Formation lies unconformably on both the Girardeau Limestone in a small area around the town of Cape Girardeau, Missouri, and on the Orchard Creek Shale in northern Cape Girardeau County. It is unconformably overlain by the Early Silurian Sexton Creek Limestone. In places, such as the type section of the Girardeau Limestone, Leemon strata are entirely missing, the Sexton Creek lying directly on the Girardeau Limestone.

Edgewood Group
Savage, 1909

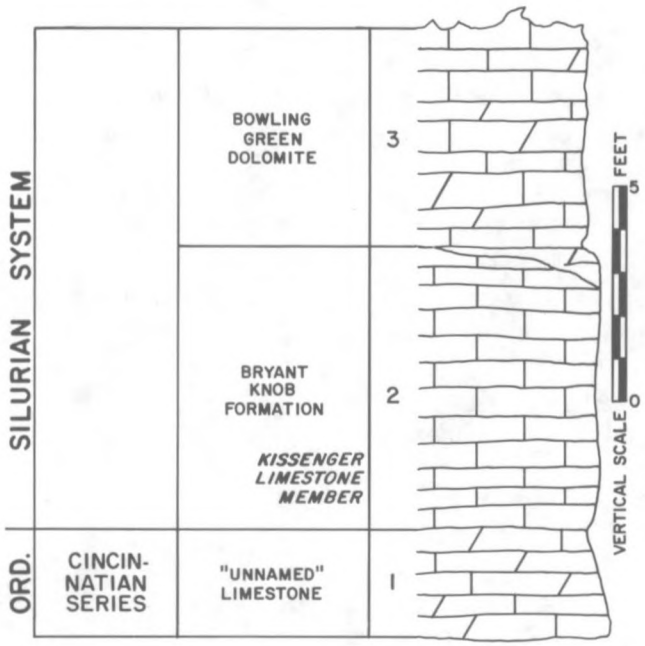
Original description -- (Savage, 1909, p. 517) "The name Edgewood limestone is here applied to the strata in this region [Alexander County, Illinois] lying above the Girardeau limestone and below the Sexton Creek formation...The name is taken from the town of Edgewood in Pike county, Missouri, near which place occur strata that have furnished fossils of that horizon in great abundance."

Savage (1913, p. 360-361) stated, "...the name Edgewood limestone is retained as the formation name, which includes all of the strata in Missouri and Illinois between the horizon of the Girardeau limestone and the top of the magnesian limestone near Bowling Green and the top of the brown limestone overlying the oolite in Lincoln, Pike, and Ralls Counties, Missouri, and on the opposite side of the river in Illinois and their equivalents elsewhere in the Mississippi Valley.

"It will be convenient, however, to subdivide the Edgewood into 3 members, as follows: (1) The Cyrene member, which will include the lower, fossiliferous limestone phase of the formation below the Bowling Green member, exposed 1 to 2 miles east of Cyrene and Edgewood, in Pike County, Missouri, and about 2 miles north of Thebes, in Alexander County, Illinois; (2) the Noix oolite member, which will refer to the local oolite facies of the formation, which is the equivalent of a variable portion of the upper part of the Cyrene member; and (3) the Bowling Green member, which will embrace the buff or brown, mostly unfossiliferous, limestone in the upper part of the formation, corresponding to the strata outcropping near Bowling Green, Missouri."

Type section -- Named for exposures 3 mi north of Edgewood, Pike County, Missouri; no specific exposure has been identified as the type section for the Edgewood.

Reference section -- One reference section (fig. 155) is on the Higginbotham farm in the SW¼ SW¼ SE¼ sec. 21, T. 53 N., R. 1 W., Cyrene 7½' Quadrangle , about 1.2 mi north of Calumet, Pike County, Missouri (Thompson and Satterfield, 1975). Several other reference sections to the Edgewood Group will be discussed under the various Ordovician formations in the group.



SILURIAN SYSTEM
Bowling Green Dolomite (4-6 ft)
3. Limestone, like no. 1; deposited on very irregular surface on top of no. 2; thickness variable. (4 ft - 6 ft)
Bryant Knob Formation
Kissenger Limestone Member (6 ft 6 in.)
2. Limestone, light-gray to gray, medium- to coarsely crystalline, coarsening upward, cross-bedded, slightly pelletal, massively bedded; upper 6 in. thin-bedded, slightly argillaceous, pelletal; numerous silicified fossils. (6 ft 6 in.)
ORDOVICIAN SYSTEM - CINCINNATIAN SERIES
"unnamed" limestone (2 ft 6 in.)
1. Limestone yellowish-buff, earthy, very porous, dolomitic; silicified fossils. (2 ft 6 in.)

Figure 155. ***Edgewood Group*** *exposed in a field and small quarry near Calumet, SW¼ SW¼ SE¼ sec. 21, T. 53 N., R. 1 W., Pike County, northeastern Missouri. Adapted from a description by Thompson and Satterfield (1975).*

Remarks -- As originally defined by Savage, the Edgewood comprised the following

Bowling Green member
Noix oolite member (related to the Cyrene)
Cyrene member

In southeastern Missouri, strata similar in age to the Cyrene were also identified as "Edgewood." Subsequent work in northeastern Missouri by Thompson and Satterfield (1971, 1975) and Amsden (1974, 1983, 1986) defined the position of the Ordovician-Silurian boundary as being between the Late Ordovician Noix oolite and the Early Silurian Bowling Green members of Savage. Where the Early Silurian Bryant Knob Formation is present beneath the Bowling Green, the boundary is between the Bryant Knob Formation and Noix (fig. 156). The formations of the Edgewood Group and their age relationships are indicated on the following diagram:

<table>
<tr><td rowspan="2">Silurian</td><td>Bowling Green Dolomite</td><td rowspan="3">Edgewood Gp</td></tr>
<tr><td>Bryant Knob Formation
Kissenger Limestone Member</td></tr>
<tr><td rowspan="3">Ordovician</td><td>Cyrene Limestone - Noix Limestone</td></tr>
<tr><td>Maquoketa Shale</td><td></td></tr>
<tr><td>Kimmswick Limestone</td><td></td></tr>
</table>

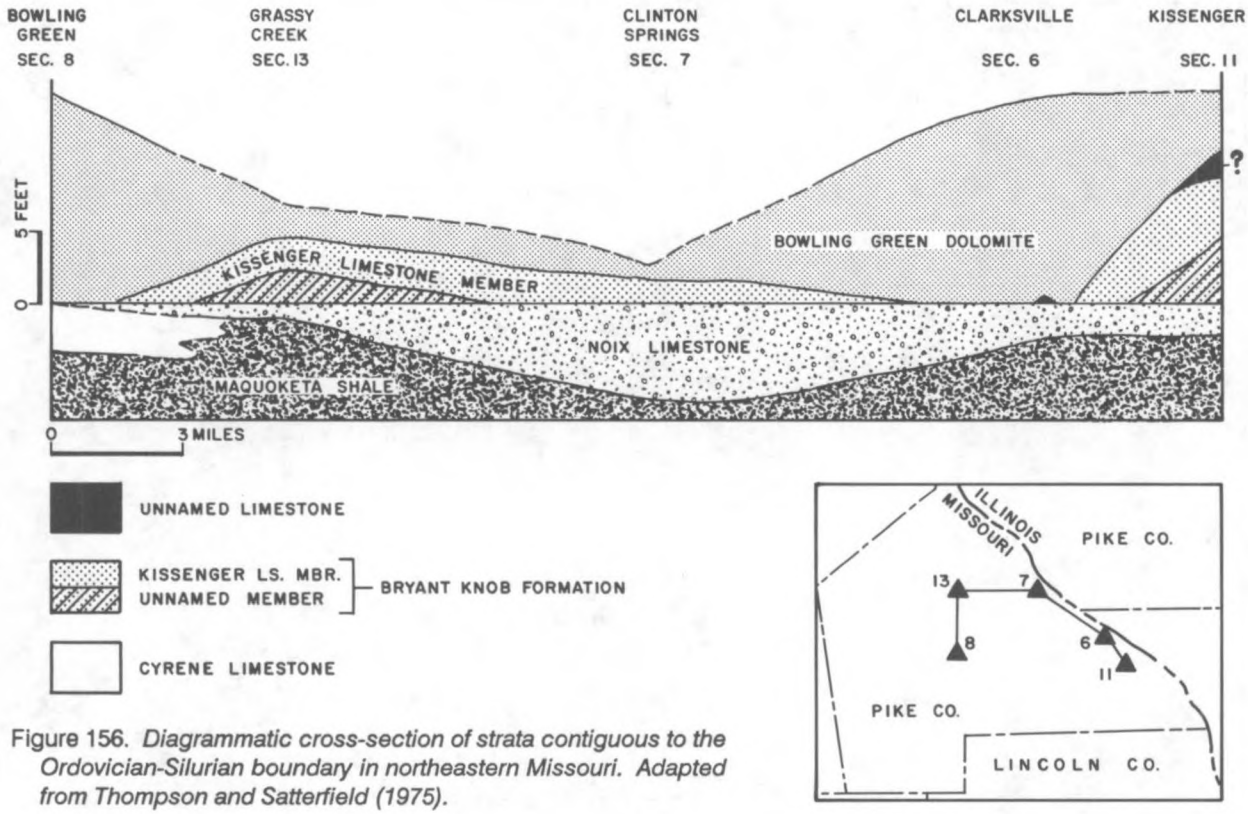


Figure 156. *Diagrammatic cross-section of strata contiguous to the Ordovician-Silurian boundary in northeastern Missouri. Adapted from Thompson and Satterfield (1975).*

Late Ordovician strata in southeastern Missouri and southwestern Illinois, formerly called Edgewood and correlated with type Edgewood primarily on faunal evidence, were renamed the **Leemon Formation** by Thompson and Satterfield (1975), whereas in the type region of the Edgewood, the name Edgewood was retained as a group, comprising the Late Ordovician **Noix Limestone** and **Cyrene Limestone** and the Silurian Bryant Knob Formation and Bowling Green Dolomite.

Cyrene Limestone

Savage, 1913; Thompson and Satterfield, 1975

Original description -- (Savage, 1913, p. 361) "(1) The Cyrene member, which will include the lower fossiliferous limestone phase of the [Edgewood] formation below the Bowling Green member, exposed 1 to 2 miles east of Cyrene and Edgewood, Pike County, Missouri..."

Thompson and Satterfield (1975, p. 96) added, "At the Bowling Green roadcut, the Cyrene is a 2-m-thick, gray to bluish-gray, fine- to medium-crystalline, fossiliferous, dolomitic limestone. Fossil distribution is not uniform, but fossils are numerous along bedding planes. Beds are 6- to 12-cm-thick in the upper part of this unit, and the top is marked by an irregular 8- to 12-cm-thick, coarse-grained limestone containing scattered oolites (unit 5A). Phosphatic debris and pyrite are common in acid residues from this limestone. A prominent shale parting separates unit 5A from the overlying Bowling Green Dolomite.

"The same lithic type is present at the type Cyrene of Savage and is distinct from the limestone of the Bryant Knob Formation. We have not seen this dolomitic limestone east of these two exposures and have not found it where the Bryant Knob and Noix Limestone are present."

Type section -- Savage (1913, p. 361) located the Cyrene only as "1 to 2 miles east of Cyrene and Edgewood, Pike County, Missouri." Rowley (1916, p. 319) stated that "The type locality for the member is generally known as the Wigginton place, and is at the foot of a hill locally known as Buffalo Knob." Thompson and Satterfield (1975, p. 82) stated, "We have located this section in the SW¼ NW¼ sec. 8, T.

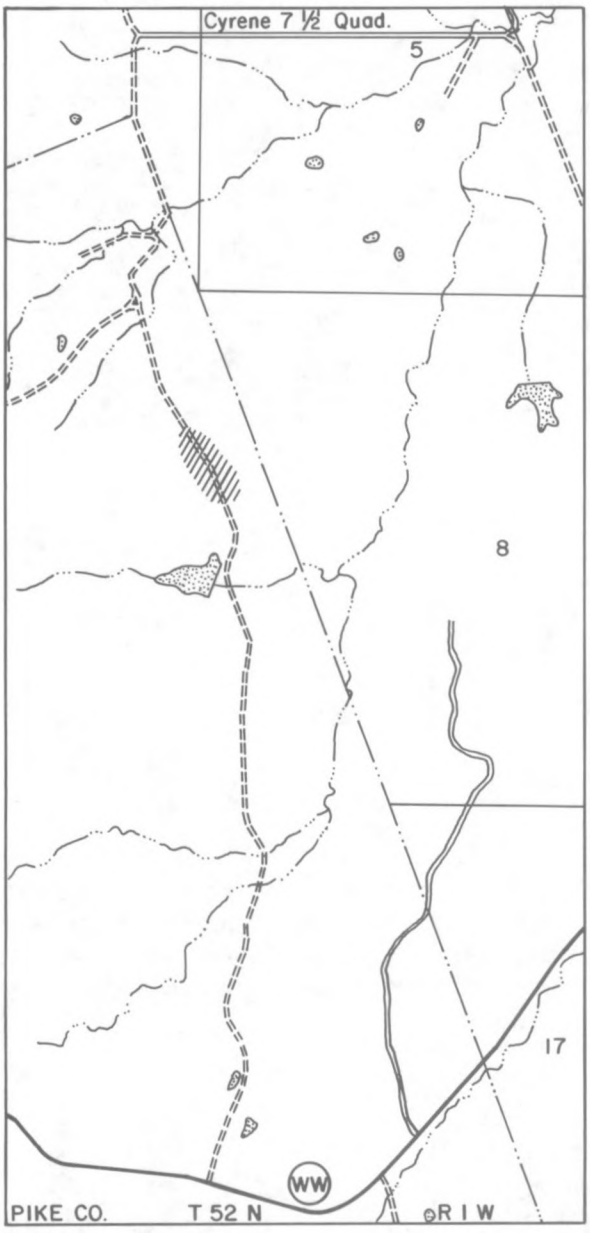


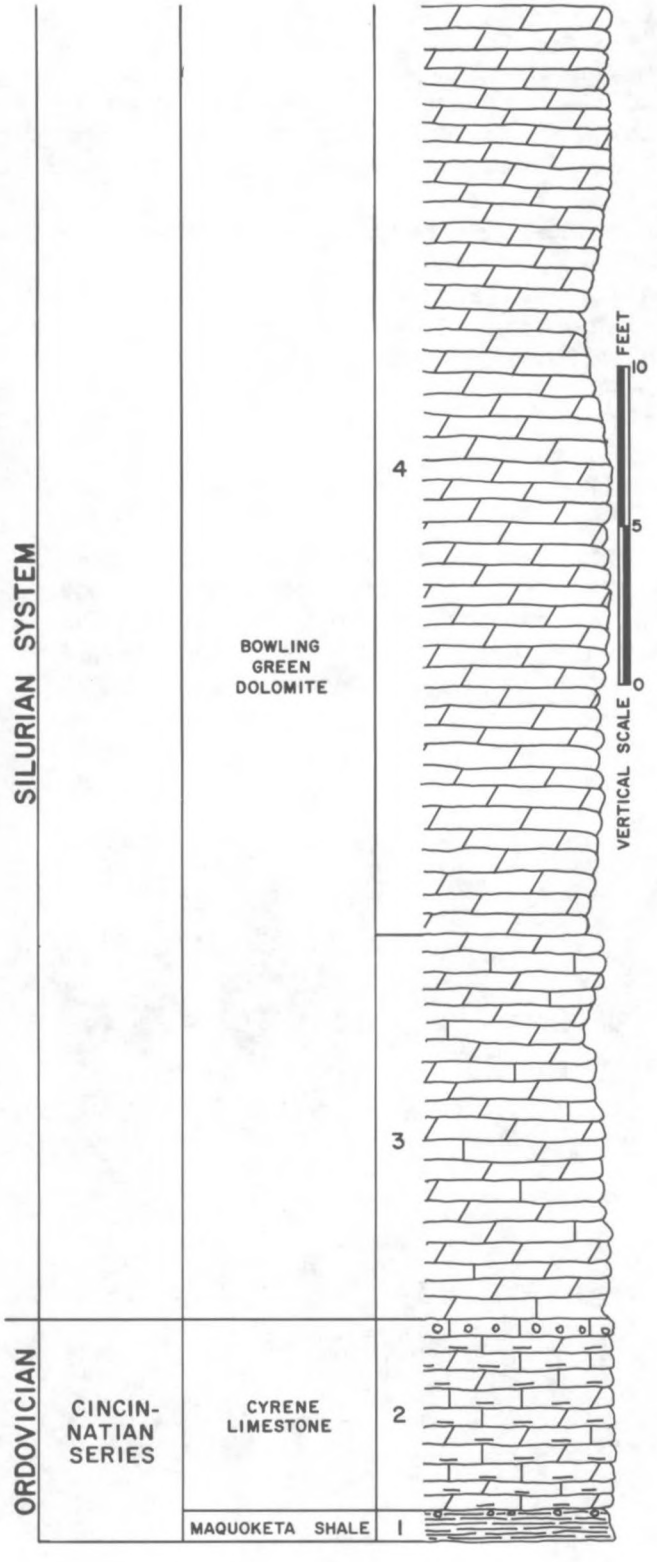
Figure 157. *Part of the Cyrene 7½' Quadrangle, showing the location of the type section of the* **Cyrene Limestone,** *SW¼ NW¼ sec. 8, T. 52 N., R. 1 W., Pike County, northeastern Missouri.*

52 N., R. 1 W. It is the only exposure in the vicinity designated by Savage (1913)." The section (fig. 157) is located in Pike County, northeastern Missouri, Cyrene 7½' Quadrangle.

Reference section -- An excellent exposure of the Cyrene Limestone, described in detail by Thompson and Satterfield (1975, p. 88) and Amsden (1986, p. 38), is in a roadcut on business route U.S. Highway 54, 0.25 mi east of the junction with U.S. Highway 61 bypass (figs. 158 and 159), north of the north edge of Bowling Green, NW¼ NW¼ sec. 24, T. 53 N., R. 3 W., Pike County, Missouri, Bowling Green 7½' Quadrangle.

History of nomenclature

1913	**Savage**	**Cyrene member of Edgewood formation**
1914	Keyes	Bowling Green formation (part; rejected Savage's "Cyrene")
1916	Rowley	Cyrene member of Edgewood formation Watson limestone



SILURIAN SYSTEM

Bowling Green Dolomite (48 ft)

4. Dolomite, buff, finely crystalline, porous, massive; thick bedded; few scattered chert nodules; silicified fossil fragments. (36 ft)
3. Dolomite, brown, finely crystalline, porous, calcareous; little or no chert; base at top of thin oolitic limestone. (12 ft)

ORDOVICIAN SYSTEM - CINCINNATIAN SERIES

Cyrene Limestone (6-8 ft)

2. Limestone, bluish-gray, dolomitic, argillaceous; zone of white oolites 3-6 in. below prominent shale break at top of unit; fossiliferous. (6-8 ft)

Maquoketa Shale (1 ft+)

1. Shale, blue-gray; oolites in upper part (1 ft)

Figure 158. **Cyrene Limestone** *and overlying Bowling Green Dolomite in a roadcut on Bowling Green city route U.S. Highway 54, 1 mi east of Bowling Green, NW¼ NW¼ sec. 24, T. 53 N., R. 3 W., Pike County, northeastern Missouri, Bowling Green 7½' Quadrangle. Adapted from a description by Thompson and Satterfield (1975).*

(not) 1924	Krey	Cyrene limestone member of Edgewood formation (= Silurian Bryant Knob Formation)
1926	Flint and Ball	Cyrene of Edgewood limestone
(not) 1941	McQueen et al.	Cyrene limestone member of Edgewood formation
(not) 1957	Laswell	Cyrene limestone member of Edgewood formation (part = Silurian Bryant Knob Formation; part = Noix Limestone)
(not) 1961	Martin et al. (b)	Cyrene member of Edgewood formation (= Bryant Knob and Noix Formations)
(not) 1961	Koenig et al.	Cyrene member of Edgewood formation
1975	**Thompson and Satterfield**	**Cyrene Formation of Edgewood Group (as originally defined by Savage, 1913)**
1982	McCracken and Barnes	Cyrene Formation of Edgewood Group
1986	Amsden	Cyrene Formation
1987	Ausich	Cyrene Formation
1991	**Thompson (present report)**	**Cyrene Limestone of Edgewood Group**

Remarks -- Savage proposed the name "Cyrene" for a fossiliferous dolomitic limestone that crops out in northeastern Missouri, lying on the Maquoketa Shale and beneath Bowling Green Dolomite. Because of an oolite zone near the top of the Cyrene, he believed the upper part represented a facies of the oolitic Noix Limestone exposed a few miles east of the Cyrene outcrops. Krey (1924), however, applied "Cyrene" to a bioclastic limestone immediately above the Noix, in exposures along the Mississippi River Valley, in

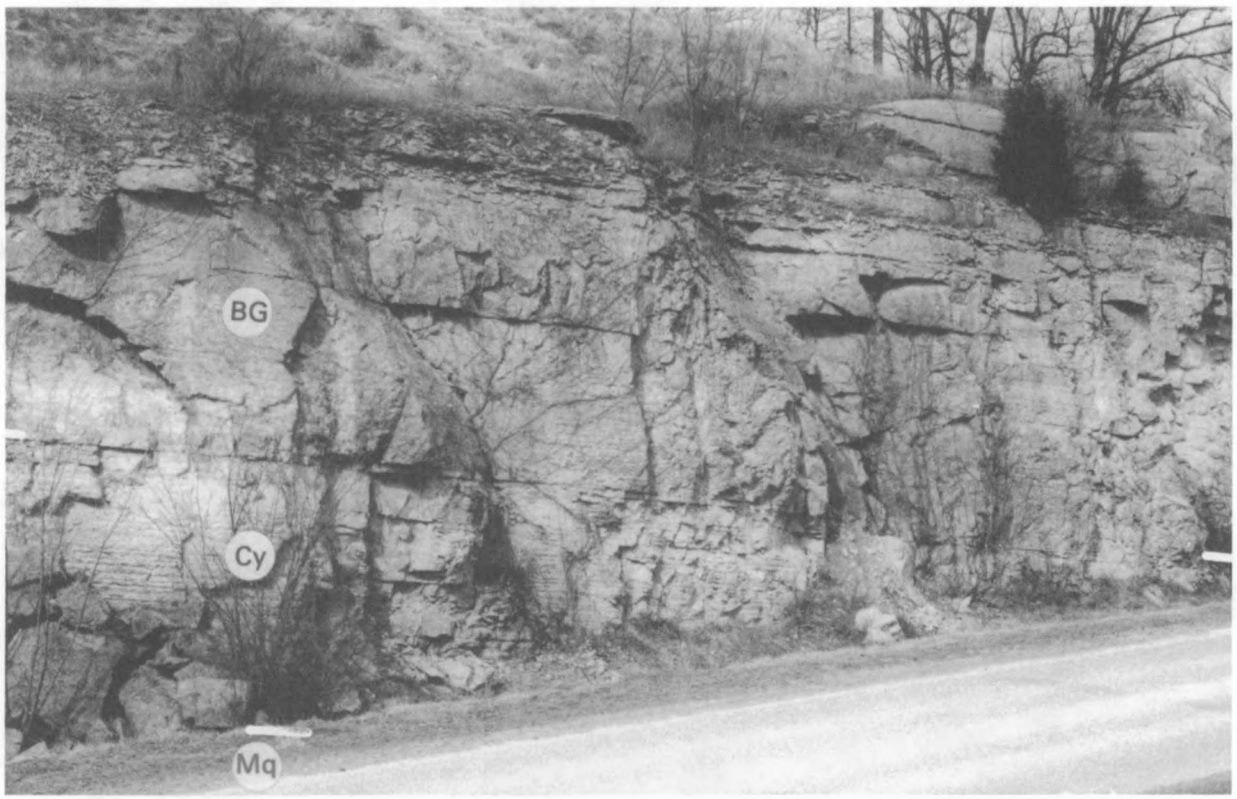


Figure 159. **Cyrene Limestone (Cy), *Maquoketa Shale* (Mq),** *and overlying Bowling Green Dolomite* **(BG)** *in a roadcut on Bowling Green city route U.S. Highway 54, NW¼ NW¼ sec. 24, T. 53 N., R. 3 W., Pike County, northeastern Missouri (fig. 158). Photograph by T.L. Thompson.*

a limited region of northeastern Missouri. He misinterpreted Savage's concept of the Noix as "the equivalent of a variable portion of the upper part of the Cyrene member." To Savage the Noix was a facies of the upper Cyrene; to Krey, the basal member of the Cyrene.

Thompson and Satterfield (1975) verified the lateral relationship of the Cyrene and Noix (fig. 156) as defined by Savage and proposed to retain Cyrene as originally proposed. The coarsely crystalline limestone Krey and many later geologists identified as "Cyrene" is Early Silurian (as opposed to the Late Ordovician Noix and Cyrene of Savage), and was renamed the **Bryant Knob Limestone** of the Edgewood Group.

Martin et al. (1961b, p. 34) described both the "light gray, medium to coarsely crystalline limestone" and the "bluish-gray to brown dolomitic limestone" as the "Cyrene member of the Edgewood formation"; they included both the Late Ordovician and Early Silurian strata as equivalent units. Only the "bluish-gray to brown dolomitic limestone" is considered to fall within the present definition of the Cyrene Limestone.

The Cyrene Limestone is 0 to 6 ft thick in a limited region of eastern Pike County, in northeastern Missouri. It lies on Maquoketa Shale and underlies the Bowling Green Dolomite of the Edgewood Group. In some sections a thin, 4- to 6-in. dolomitic limestone zone at the top of the Cyrene contains scattered oolites (figs. 158 and 159), interpreted by Thompson and Satterfield (1975) to indicate that the limestone is a lateral equivalent of the Noix Limestone, which is an eastern facies of the Cyrene Limestone.

Noix Limestone

Keyes, 1898; Thompson and Satterfield, 1975

Original description -- (Keyes, 1898, p. 62) "*Noix Oolite*.-- Immediately above the Ordovician shales at Louisiana and in the vicinity, is a very white, massive oolite, containing numerous fossils and having a thickness of four to seven feet and upwards. Its areal distribution is over 100 square miles."

Type section -- Keyes (1898, p. 62) stated that the Noix "... is best exposed, perhaps, in the immediate neighborhood of Louisiana in the valley of Noix creek and along the bluffs of the Mississippi river. From this locality it extends westward and southward, reaching the northern part of Lincoln county, Missouri, where it occurs in isolated areas in the tops of the hills."

As a specific type section had not been designated, Thompson and Satterfield (1975, p. 89) stated, "We designate the type section to be at Clinton Springs...in the SW¼ NE¼ NW¼ sec. 29 [mislocated, should be sec. 20], T. 54 N., R. 1 W., Pike County, Missouri, a roadcut along Missouri Highway 79 at the south edge of the town of Louisiana. This section is near the mouth of Noix Creek, within the area Keyes (1898, p. 62) considered Noix to be 'best exposed'. At the type section [figs. 160 and 161], about 2 m of Noix are exposed...The light gray, bioclastic limestone (Kissenger Limestone Member of the Bryant Knob Formation) overlies the Noix, and is in turn overlain by a few centimeters to 0.6 m of Bowling Green Dolomite. The bioclastic limestone thins rapidly to the west along the outcrop and probably is absent within 200 m."

Reference sections -- An excellent exposure of the Noix Limestone is a roadcut on Missouri Highway 79 at the north edge of Clarksville (figs. 162 and 163), NW¼ sec. 9, T. 53 N., R. 1 E., Pike County, Missouri, Clarksville 7½' Quadrangle. This section was also described by Thompson and Satterfield (1975, sec. 6).

History of nomenclature

1855	Swallow	white oolite bed near Louisiana, Mo. (Onondaga)
1873	Potter	"oolite of Lincoln county"
1898	**Keyes**	**Noix oolite**
1912	Willis	Niagara limestone (lower part)
1913	Savage	Noix oolite member of Edgewood limestone
1914	Keyes	Noix limestone (rejected "Edgewood")
1924	Krey	Noix oolite of Cyrene member of Edgewood formation
1950	Bassler	Noix oolite member of Edgewood limestone

1957	Laswell	oolitic bed in Cyrene limestone member of Edgewood formation (Noix oolite)
1961	Martin et al. (b)	Noix oolite of Cyrene member of Edgewood formation
1969	Craig	Noix Oolite Member of Edgewood Dolomite (Silurian in age)
1971	Thompson and Satterfield	Noix oolite
1974	Amsden	Noix Limestone of Edgewood Group (from ms. of Thompson and Satterfield)
1975	**Thompson and Satterfield**	**Noix Limestone of Edgewood Group** (Late Ordovician)
1982	Ross et al.	Noix Limestone
	McCracken and Barnes	Noix Limestone of Edgewood Group
1987	Ausich	Noix Limestone
1991	**Thompson (present report)**	**Noix Limestone of Edgewood Group**

Remarks -- As described by Thompson and Satterfield (1975, p. 89), the Noix is a thin (0.5 - 2 m) limestone

> "...composed almost entirely of concentrically banded oolites in a very finely crystalline, micritic matrix. The unit is stylolitic and cross-bedded, and glauconite and phosphatic grains are common in the lower part."

In places the Noix is almost conglomeratic.

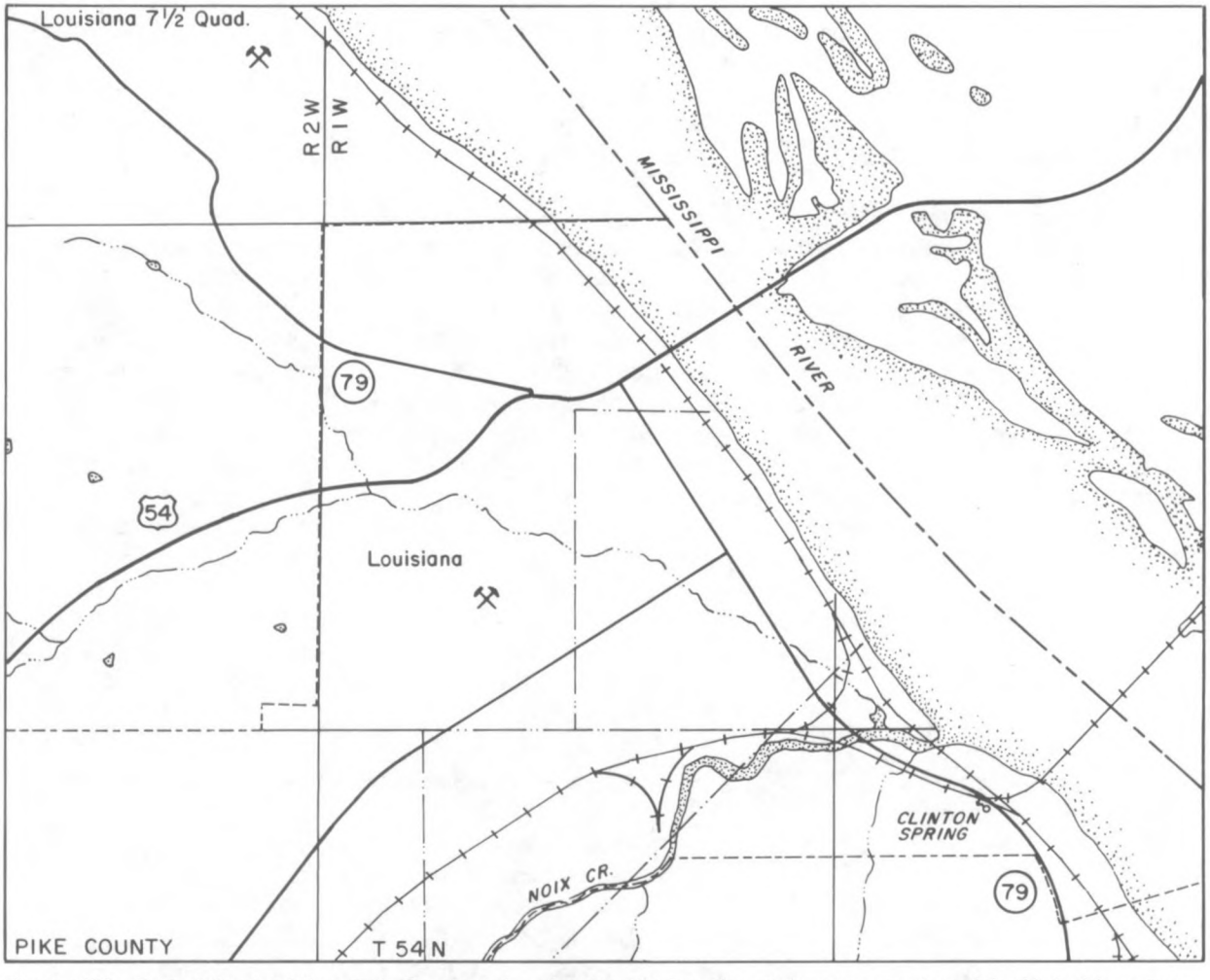
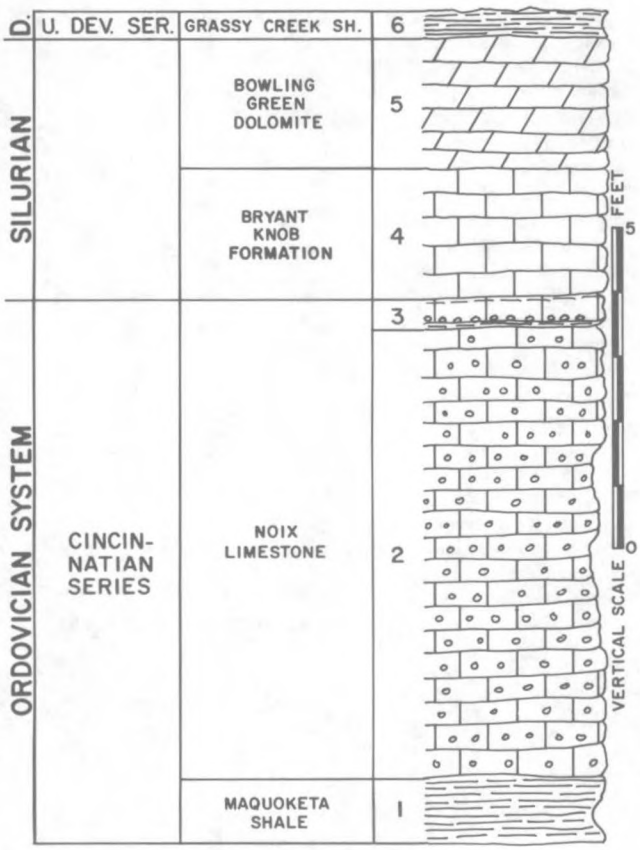


Figure 160. *Part of the Louisiana 7½' Quadrangle, showing the location of the type section of the* **Noix Limestone,** *Clinton Spring, SW¼ NE¼ NW¼ sec. 20, T. 54 N., R. 1 W., Pike County, northeastern Missouri.*



DEVONIAN SYSTEM - UPPER DEVONIAN SERIES

Louisiana Limestone

Covered interval (?)

Grassy Creek Shale (8 in.+)

6. Shale, gray, fissile, platy; mostly covered. (8 in. exposed)

SILURIAN SYSTEM

Bowling Green Dolomite (2 ft)

5. Dolomite, buff, very finely crystalline, slightly porous, calcareous; no apparent sedimentary structures. (2 ft)

Bryant Knob Formation (2 ft)

Kissenger Limestone Member (2 ft)

4. Limestone, light-gray to gray, fine- to medium-crystalline, massive; very fossiliferous. (2 ft)

ORDOVICIAN SYSTEM - CINCINNATIAN SERIES

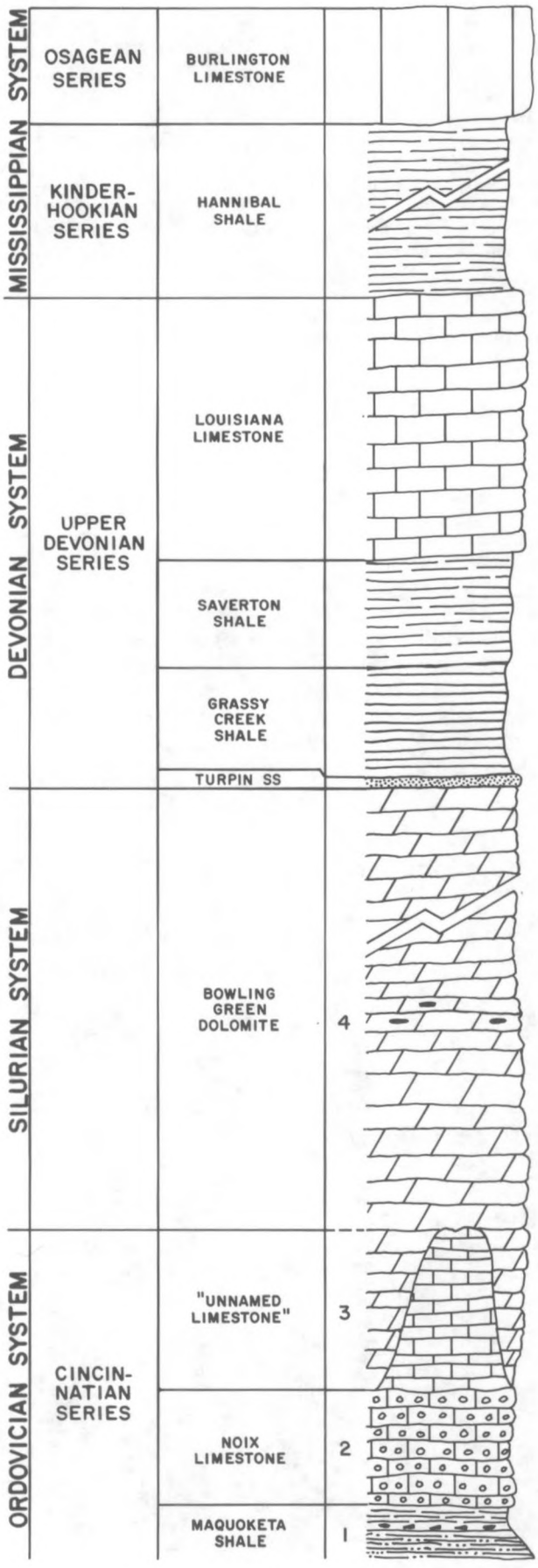
Noix Limestone (7 ft)

3. Limestone, gray; oolitic in basal 1 in., upper 1-2 in silt-sized oolites; separated from no. 1 by 0.25-0.5 in. green shale, thinner green shale at top. (2-5 in.)
2. Limestone, grayish-white; very oolitic; small scale cross-bedding; very stylolitic; massive; basal 1 ft very glauconitic, with green clay pebbles (Maquoketa); silicified brachiopods and crinoid fragments. (7 ft)

Maquoketa Shale (1 ft)

1. Shale, green-gray, clayey. (1 ft)

Figure 161. *Type section of the* **Noix Limestone**, *SW¼ NE¼ NW¼ sec. 20, T. 54 N., R. 1 W., Pike County, northeastern Missouri (fig. 160). Adapted from a description by Thompson and Satterfield (1975).* **(Nx)** *Noix Limestone;* **(BK)** *Bryant Knob Formation;* **(BG)** *Bowling Green Dolomite. Photograph by T.L. Thompson.*



MISSISSIPPIAN SYSTEM - OSAGEAN SERIES
Burlington Limestone
KINDERHOOKIAN SERIES
Hannibal Shale
DEVONIAN SYSTEM - UPPER DEVONIAN SERIES
Louisiana Limestone
Saverton Shale (2 ft)
Grassy Creek Shale (2 ft)
Turpin Sandstone (1 in.)
SILURIAN SYSTEM
Bowling Green Dolomite (26 ft)

4. Dolomite, buff, finely crystalline, very earthy, calcareous, porous; numerous fossil molds; scattered chert nodules in middle part; essentially one bed. (26 ft)

ORDOVICIAN SYSTEM - CINCINNATIAN SERIES
"unnamed" limestone (0-6 ft)

3. Limestone, very light-gray to off-white, fine-grained calcarenite, vuggy; thin shale beneath and above; as small mound-like units between Noix and Bowling Green. (0-6 ft)

Noix Limestone (2 ft 9 in.)

2. Limestone, grayish-white to buff, massive; very oolitic; slightly cross-bedded; glauconitic; stylolitic; a few lithographic limestone pebbles. (2 ft 9 in.)

Maquoketa Shale (35 ft+)

1. Shale, bluish-green, clayey; thin-bedded; to road level. (35 ft)

Figure 162. **Noix Limestone** *and overlying Bowling Green Dolomite (Lower Silurian) in a roadcut on Missouri Highway 79 north of Clarksville, NW¼ sec. 9, T. 53 N., R. 1 E., Pike County, northeastern Missouri. Adapted from a description by Thompson and Satterfield (1975). Not to scale.*

The Noix Limestone rests disconformably on the Maquoketa Shale and is disconformably to unconformably overlain by Lower Silurian strata (fig. 156). Regionally, the Noix is known in outcrops from as far north as Saverton to south of Clarksville, southern Ralls and Pike counties, Missouri, respectively; it extends at least 7 mi westward from the outcrops along the bluffs of the Mississippi River Valley (a region approximately 45 mi by 7 mi). Rocks of the Noix Limestone (or equivalent) have also been reported from outcrops in eastern Iowa (Witzke and Heathcote, 1983; Mikulic, 1983).

Amsden (1974, p. 13) considered the brachiopod fauna of the Noix to be "suggestive of the late Ashgillian *Hirnantia* fauna of Europe." He correlated the Noix with the **Leemon Formation** of southeastern Missouri and southwestern Illinois and the **Keel Formation** of south-central Oklahoma. Conodonts recovered by Thompson and Satterfield (1975), including *Prioniodus ferrarius, P. girardeauensis*, and *Trichonodella asymmetrica,* are similar to those reported by Satterfield (1971) from the Girardeau Limestone of southeastern Missouri. They indicate a post-Maquoketa Late Ordovician (Cincinnatian) age for the Noix Limestone and confirmed the Noix-Leemon correlation of Amsden.

Figure 163. **Noix Limestone** *and overlying Lower Silurian formations in a roadcut on Missouri Highway 79 north of Clarksville, NW¼ sec. 9, T. 53 N., R. 1 E., Pike County, northeastern Missouri (fig. 162).* (**Mq**) *Maquoketa Shale;* (**Nx**) *Noix Limestone;* (**un**)*"unnamed" limestone;* (**BG**) *Bowling Green Dolomite. Photograph by T.L. Thompson.*

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